

CONSENSUS STATEMENT

Consensus Statements of the American College of Veterinary Internal Medicine (ACVIM) provide the veterinary community with up-to-date information on the pathophysiology, diagnosis, and treatment of clinically important animal diseases. The ACVIM Board of Regents oversees selection of relevant topics, identification of panel members with the expertise to draft the statements, and other aspects of assuring the integrity of the process. The statements are derived from evidence-based medicine whenever possible and the panel offers interpretive comments when such evidence is inadequate or contradictory. A draft is prepared by the panel, followed by solicitation of input by the ACVIM membership which may be incorporated into the statement. It is then submitted to the Journal of Veterinary Internal Medicine, where it is edited before publication. The authors are solely responsible for the content of the statements.

ACVIM consensus statement on the diagnosis of immune thrombocytopenia in dogs and cats

Dana N. LeVine¹  | Linda Kidd^{2,3}  | Oliver A. Garden⁴  |
 Marjory B. Brooks⁵  | Robert Goggs⁶  | Barbara Kohn⁷ | Andrew J. Mackin⁸  |
 Erin R. B. Eldermire⁹ | Yu-Mei Chang¹⁰  | Julie Allen¹¹ |
 Peter W. Christopherson¹² | Barbara Glanemann¹³  | Haruhiko Maruyama¹⁴ |
 Maria C. Naskou¹²  | Lise N. Nielsen¹⁵  | Sarah Shropshire¹⁶ |
 Austin K. Viall¹⁷ | Adam J. Birkenheuer¹⁸  | Marnin A. Forman¹⁹ |
 Andrew S. Hanzlicek²⁰  | Kathrin F. Langner²¹  | Erin Lashnits²²  |
 Katharine F. Lunn²³  | Kelly M. Makielski²⁴  | Xavier Roura²⁵ | Eva Spada²⁶ 

Correspondence

Linda Kidd, Linda Kidd Veterinary Internal
 Medicine Consulting, Carlsbad, CA, USA.
 Email: lindabkidd@gmail.com

Abstract

Immune thrombocytopenia (ITP) is the most common acquired primary hemostatic disorder in dogs. Immune thrombocytopenia less commonly affects cats but is an important cause of mortality and treatment-associated morbidity in both species. Immune thrombocytopenia remains a diagnosis of exclusion for which diagnostic guidelines are lacking. Primary, or non-associative, ITP refers to autoimmune platelet destruction. Secondary, or associative, ITP arises in response to an underlying disease trigger. However, evidence for which comorbidities serve as ITP triggers has not been systematically evaluated. To identify key diagnostic steps for ITP and important comorbidities associated with secondary ITP, we developed 12 Population Evaluation/Exposure Comparison Outcome (PECO) format questions. These questions were addressed by evidence evaluators utilizing a literature pool of 287 articles

Abbreviations: AAEP, American Association of Feline Practitioners; EE, evidence evaluator; FeLV, feline leukemia virus; FIV, feline immunodeficiency virus; GPs, glycoproteins; IME, integrated measure of evidence; IMHA, immune-mediated hemolytic anemia; IPF, immature platelet fraction; ITP, immune thrombocytopenia; MPV, mean platelet volume; PECO, population evaluation/exposure comparison outcome; PSAIG, platelet surface-associated immunoglobulin; TPO, thrombopoietin.

For affiliations refer to page 1975

This is an open access article under the terms of the [Creative Commons Attribution-NonCommercial-NoDerivs](https://creativecommons.org/licenses/by-nc-nd/4.0/) License, which permits use and distribution in any medium, provided the original work is properly cited, the use is non-commercial and no modifications or adaptations are made.

© 2024 The Authors. *Journal of Veterinary Internal Medicine* published by Wiley Periodicals LLC on behalf of American College of Veterinary Internal Medicine.

identified by the panelists using a structured search strategy. Evidence evaluators, using panel-designed templates and data extraction tools, summarized evidence and created guideline recommendations that then were integrated by diagnosis and comorbidity domain chairs. The revised PECO responses underwent a Delphi survey process to reach consensus on final guidelines. A combination of panel expertise and PECO responses were employed to develop algorithms for diagnosis of ITP in dogs and cats, which also underwent 4 iterations of Delphi review. Comorbidity evidence evaluators employed an integrated measure of evidence (IME) tool to determine evidence quality for each comorbidity; IME values combined with evidence summaries for each comorbidity were integrated to develop ITP screening recommendations, which also were subjected to Delphi review. Commentary was solicited from multiple relevant professional organizations before finalizing the consensus. The final consensus statement provides clinical guidelines for the diagnosis of, and underlying disease screening for, ITP in dogs and cats. The systematic consensus process identified numerous knowledge gaps that should guide future studies. This statement is a companion manuscript to the ACVIM Consensus Statement on the Treatment of Immune Thrombocytopenia.

KEYWORDS

autoimmune, hemostasis, immune-mediated, platelet, thrombopoietin

1 | INTRODUCTION

Immune thrombocytopenia (ITP) is the most common acquired primary hemostatic disorder in dogs,¹ and although less common, ITP does occur in cats. The mortality rate of ITP in dogs and cats ranges from 10% to 30% and substantial immunosuppressant treatment-related morbidity occurs.²⁻⁵ In severe ITP in humans, mortality results equally from secondary infections associated with immunosuppression and from refractory hemorrhage.⁶ Because ITP is potentially fatal and managed with potent immunosuppressants, rapid and accurate disease diagnosis is critical. Presently, ITP in dogs and cats is a diagnosis of exclusion that lacks definitive diagnostic criteria. A similar diagnostic ambiguity exists for ITP in humans, precluding adoption of well-defined human ITP guidelines.

The lack of a diagnostic test for ITP can be attributed to ITP's heterogeneous nature, with interpatient variability in pathogenesis, disease course, and response to treatment. In people, the pathogenesis of ITP involves autoantibodies targeting platelet surface glycoproteins (GPs) resulting in Fc gamma receptor (FcγR)-mediated platelet clearance by the mononuclear phagocytic system. In addition, antibody-triggered platelet desialylation may result in Ashwell-Morell receptor-mediated removal by hepatocytes or clearance by hepatic Kupffer cells.⁷⁻¹⁰ Complement-mediated platelet destruction also may contribute in some cases.¹¹ Cytotoxic T cell-mediated platelet destruction may occur in the absence of detectable platelet autoantibodies.^{7,12-15} Antibodies and T cells also can target megakaryocytes, inhibiting platelet production.⁷ Thrombopoietin (TPO) is the major regulator of platelet production and is necessary for survival, proliferation, and differentiation of megakaryocytes to platelets.¹⁶⁻¹⁸ Inappropriately low TPO concentrations are common in human ITP patients, contributing

to decreased platelet production.¹⁶⁻¹⁸ Platelet- and megakaryocyte-associated antibodies have been documented in dogs with ITP using assays that have variable sensitivity and specificity (see Section 4.1.7 below).¹⁹⁻²¹ It is likely that antibody-independent mechanisms of immune-mediated destruction occur, as described in humans.¹⁵ Variable mechanisms of platelet destruction contribute to ITP's diagnostic complexity.

Immune thrombocytopenia can be spontaneous (primary, or non-associative) or induced by a putative trigger (secondary, or associative). We chose to use “primary” and “secondary” in keeping with the standard nomenclature in human medicine. Secondary ITP pathogenesis and presentation varies with the underlying cause, resulting in disease heterogeneity. Treatment of secondary ITP aims to eliminate disease triggers, but inciting causes of ITP in dogs and cats have not been systematically reviewed. Guidelines for investigation of potential ITP triggers are needed to improve case management.

The clinical presentation of primary ITP is also variable, with limited association between thrombocytopenia severity and clinical signs of bleeding. Many dogs and cats remain subclinical despite severe thrombocytopenia, whereas others with similar platelet counts experience life-threatening hemorrhage.²² Biomarkers of disease severity are needed to guide individualized treatment.

We designed a diagnostic algorithm for systematic exclusion of other causes of thrombocytopenia as an essential aid in ITP diagnosis. Informed by systematic review of the available veterinary evidence, we also aimed to develop guidelines on (a) the diagnostic approach to ITP in dogs and cats; (b) comorbidity screening in dogs and cats with ITP; and (c) diagnostic testing to inform prognosis and guide intensity of treatment. Guidelines were developed using a standardized Population Exposure/Evaluation Comparison Outcome (PECO) question

format. Knowledge gaps in the available evidence were identified to inform future study design.

2 | MATERIALS AND METHODS

An overview of the consensus statement process is shown schematically in Figure 1 and described below. A comprehensive literature

search strategy was developed to identify all manuscripts relevant to ITP in dogs and cats (detailed in Supporting Information 1). Clinical diagnostic algorithms for ITP in dogs and cats were developed and used by evidence evaluators in their literature reviews. Draft algorithms were developed (OAG, LK) based on the collective expertise of the consensus panel members and refined by panel members using a Delphi review process. The diagnostic algorithms were reviewed a final time after completion of the PECO question process.

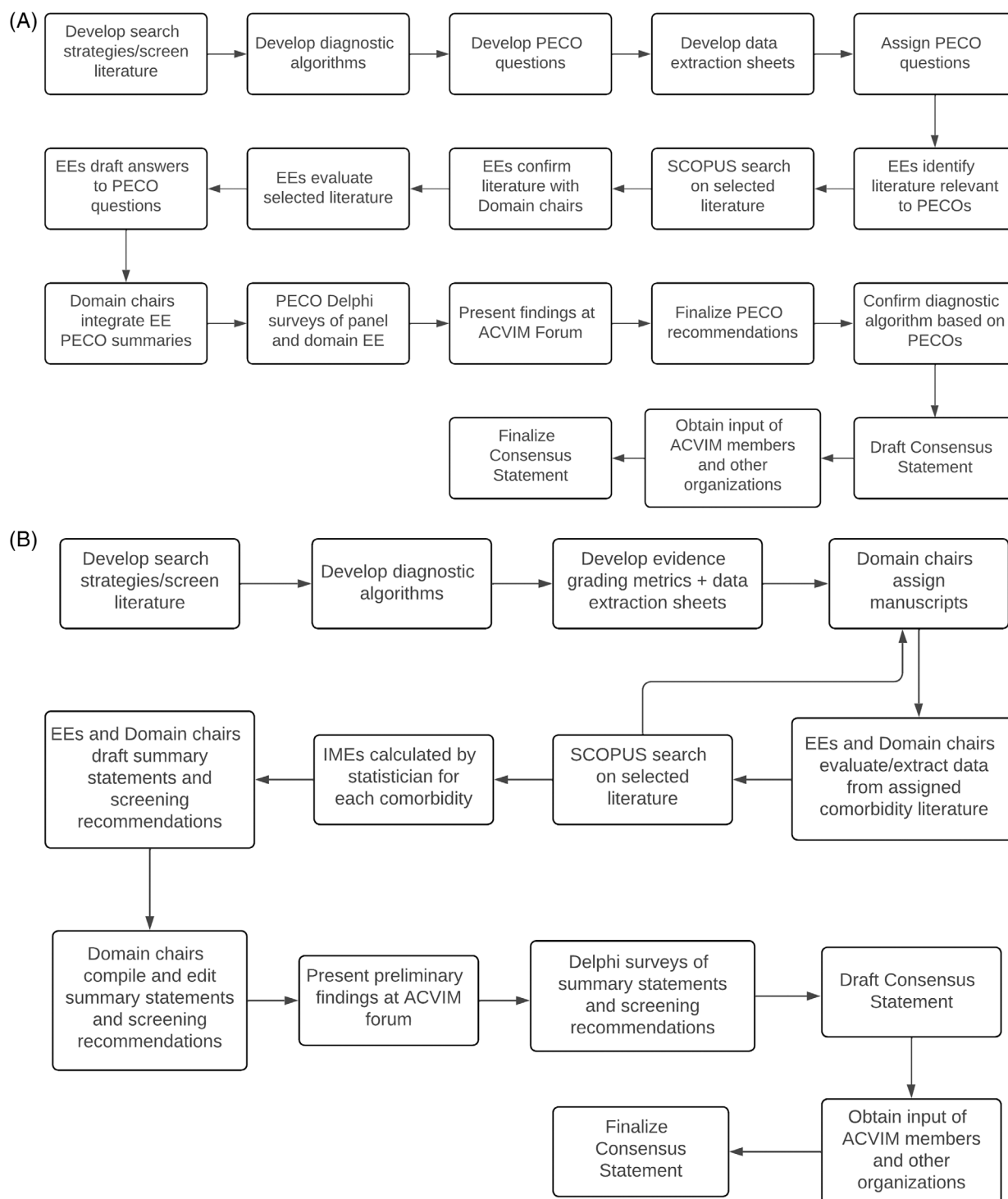


FIGURE 1 (A) Overview of the methodology of the Diagnosis Domain. (B) Overview of the methodology of the Comorbidity Domain. EE, evidence evaluator; IME, integrated metric of evidence; PECO, Population, Exposure/Evaluation, Comparison, Outcome question.

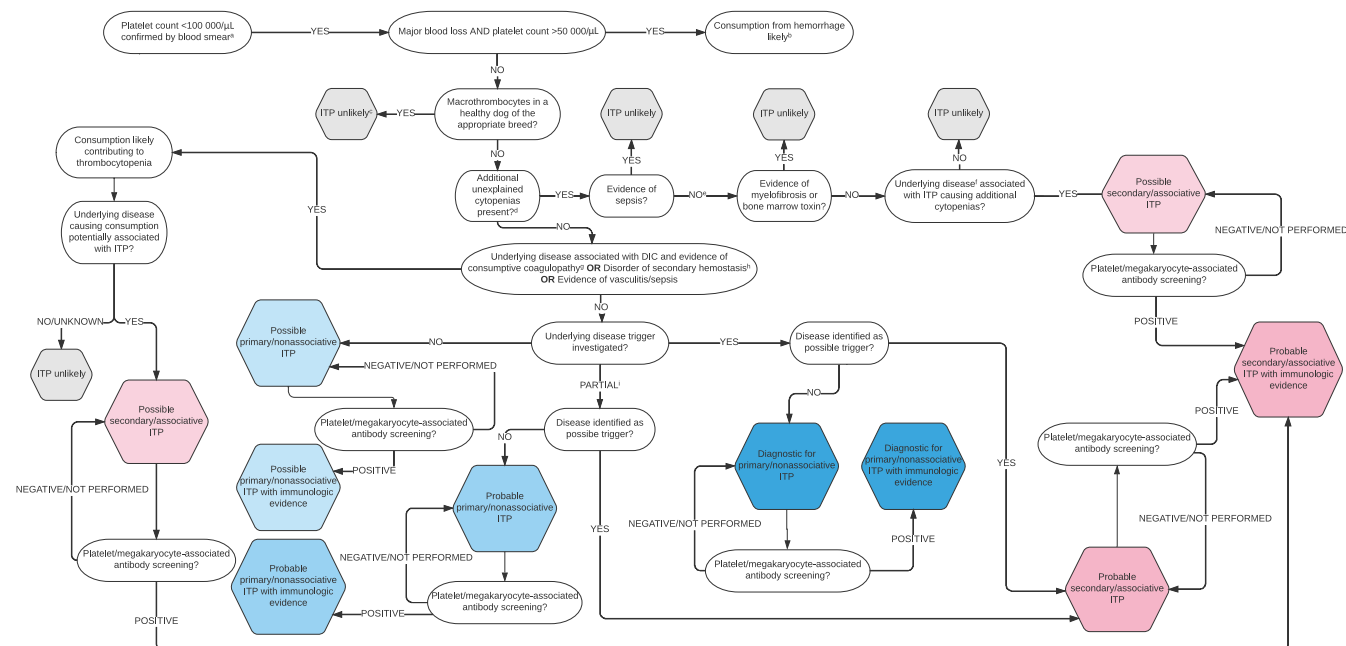


FIGURE 2 An algorithm for the diagnosis of ITP in dogs. ^aThrombocytopenia should be confirmed with a slide assessment. In brief, to perform a platelet estimate, first assess the slide body and feathered edge under low magnification for clumps, the presence of which suggests that the platelet count is falsely low. Resampling is then warranted, if possible. If there are no clumps, a platelet count is estimated by calculating the mean number of platelets per 10 oil immersion fields ($\times 100$) in the body of the smear where erythrocytes are spread in monolayer and multiplying this number by 15 000 to 20 000 to obtain the number of platelets per microliter; ^bthe magnitude of thrombocytopenia is consistent with consumption from major hemorrhage. However, it is possible that DIC, vasculitis, sequestration, or ITP may be contributing; ^cconsider genetic testing; ^dexcludes additional cytopenias with plausible explanations for example, pre-regenerative anemia in the face of acute hemorrhage or hemolysis or lymphopenia in an ill/stressed patient; ^esampling of bone marrow by aspiration, core biopsy, or both, is undertaken; ^ffor example, lymphoreticular neoplasia or ehrlichiosis; ^gat least 2 of 5 parameters abnormal in addition to thrombocytopenia: prothrombin time (PT), activated partial thromboplastin time (aPTT), D-dimers > reference interval (RI); antithrombin, fibrinogen < RI; ^hPT or aPTT >25% control value or upper bound of RI; ⁱpartial screening (ie, not exhaustive) for potential trigger factors undertaken and negative.

The literature review was divided into 2 domains: *Diagnosis* (co-chairs MBB and DNL; evidence evaluators JA, PWC, BG, HM, MCN, LNN, SS, AKV) and *Comorbidity* (co-chairs LK and OAG; evidence evaluators AJB, MAF, ASH, KFL, EL, KFL, KMM, XR, ES). Supporting Information 1 includes extended details of the methods, whereas Supporting Information 2 and 3 includes bibliographies of the manuscripts reviewed by the *Diagnosis* and *Comorbidity* domains, respectively. Supporting Information 4 includes the instruction guide sent to all *Diagnosis* evidence evaluators. Supporting Information 5 includes the instruction guide sent to all *Comorbidity* evidence evaluators.

The *Diagnosis* domain chairs generated clinical questions using a PECO format to investigate whether in dogs and cats with thrombocytopenia (P), evaluation by a diagnostic test (E) compared with platelet count alone (C) improved differentiation of ITP from non-immune thrombocytopenia (O). To investigate disease severity, *population* referred to dogs and cats diagnosed with primary ITP and *outcome* referred to disease severity encompassing bleeding risk, blood product usage, duration of hospitalization, time to platelet recovery, response to first-line treatment, or relapse. Finalized PECO questions were answered by the evidence evaluators using the identified references and structured data extraction and summary templates

(Supporting Information 6 and 7). Evaluators' PECO responses ($n = 2/\text{PECO}$) were reviewed by domain chairs and synthesized into a single consensus response to each PECO that subsequently underwent Delphi review. Consensus, or near complete consensus, was reached after 2 Delphi rounds. The remaining disagreements are indicated below.

The comorbidity PECO, "In a population of dogs or cats (P), what is the effect of exposure (E) to comorbidity X compared with a lack of exposure (C) on the development of ITP (O)?" was answered by the evidence evaluators in the *Comorbidity* domain using a quality assessment tool (Integrated Metric of Evidence; IME) and data extraction tool we adapted from the IMHA diagnosis consensus statement (Supporting Information 8 and 9).²³ Threshold IME values were computed to allow comorbidities to be designated as negligible, low, intermediate, or high evidence for a causal relationship with ITP. For the *Comorbidity* domain, manuscripts, not PECO, were assigned to 2 or 3 evidence evaluators for data extraction, evidence evaluation, and quality assessment. Evidence summaries and screening recommendations were drafted by evidence evaluators for each comorbidity in each manuscript; these summaries and recommendations then were consolidated by LK and subjected to 3 to 4 rounds of Delphi review until 100% consensus was reached.

3 | ALGORITHM FOR THE DIAGNOSIS OF ITP

Consensus on final versions of the algorithms (Figures 2 and 3) was reached after 4 rounds of revision and review. The first step of the diagnostic algorithms, “Platelet count $<100\,000/\mu\text{L}$ confirmed by blood smear examination,” warrants further emphasis. The diagnosis of ITP requires determination of platelet count. Although beyond the scope of this discussion, clinicians must consider the biologic, pre-analytic, and analytic variables that influence platelet count.²⁴⁻²⁶ Importantly, platelet activation during blood collection or processing can result in spurious thrombocytopenia.^{27,28} Pseudothrombocytopenia is especially common in cats because of variable platelet size and relative hyper-reactivity of feline platelets compared with those of other species.²⁹ Automated hematology analyzers employ different test principles, and all are subject to inherent imprecision.³⁰ Regardless of instrumentation, low platelet count should be interpreted critically in the context of allowable errors of up to 25%.²⁶ Confirmation of thrombocytopenia must include slide examination, and replicate platelet count determinations often are warranted. An appropriate diagnosis of ITP is based on persistent thrombocytopenia, and

platelet count monitoring over time is best performed using consistent methodology.³⁰

The final versions of the algorithm delineate 6 levels of diagnostic certainty for primary ITP: *Possible*, *Possible with immunologic evidence*, *Probable*, *Probable with immunologic evidence*, *Diagnostic*, and *Diagnostic with immunologic evidence*. Although we considered that immunologic evidence such as identification of platelet surface-associated immunoglobulin (PSAIG) or megakaryocyte-associated immunoglobulin strengthened the diagnosis, a confirmatory diagnosis of ITP could be made without such testing. For secondary ITP, diagnostic certainty levels include *Possible*, *Probable*, or *Probable with immunologic evidence*. Coexistence of more than 1 mechanism of thrombocytopenia in secondary ITP precludes definitive diagnosis of ITP in this context.

4 | GUIDELINES FOR DIAGNOSIS OF ITP

The diagnostic guidelines below are presented under their respective PECO questions with their evidence summaries. Guidelines for dogs and cats are presented separately. Guidelines for PECO questions for which minimal or no evidence was identified (common for cats) are included in Supporting Information 11.

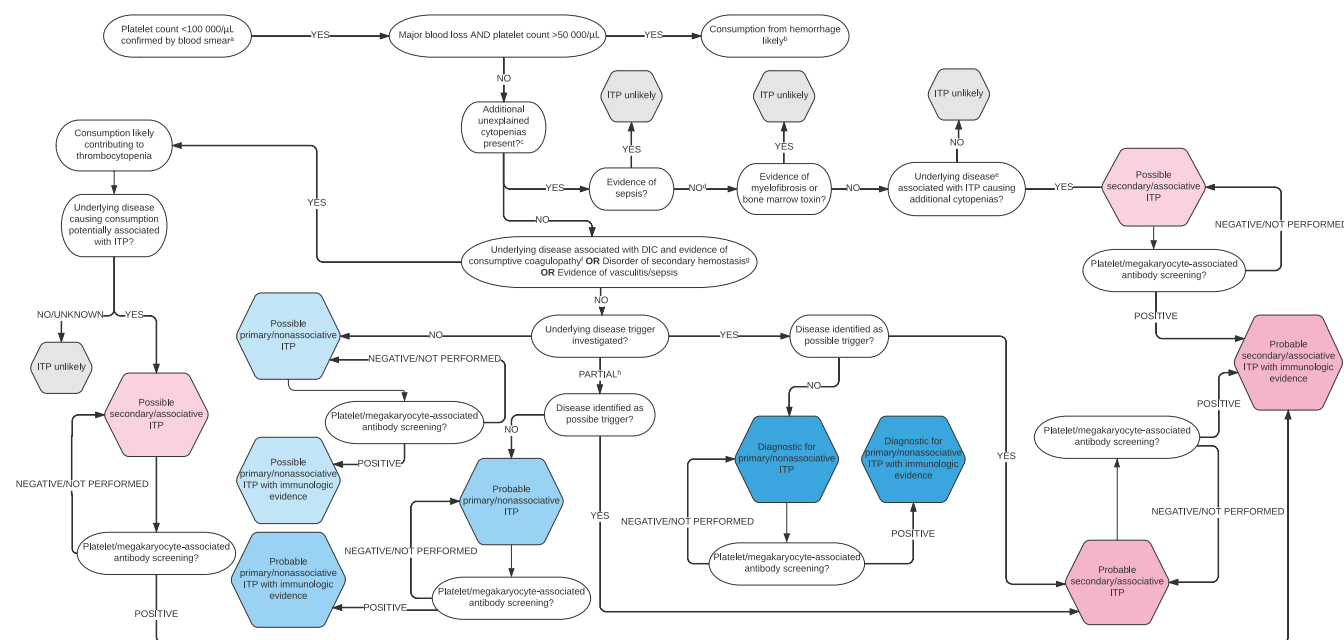


FIGURE 3 An algorithm for the diagnosis of ITP in cats. ^aThrombocytopenia should be confirmed with a slide assessment. In brief, to perform a manual count first assess the slide's feathered edge under low magnification for clumps, the presence of which suggests that the platelet count is falsely low. Resampling is then warranted, if possible. If there are no clumps, a platelet count is estimated by calculating the mean number of platelets per 10 oil immersion fields ($\times 100$) and multiplying this number by 15 000 to 20 000 to obtain the number of platelets per microliter; ^bthe magnitude of thrombocytopenia is consistent with consumption from major hemorrhage; this is a rare association in cats. However, it is possible that DIC, vasculitis, sequestration, or ITP may be contributing; ^cexcludes additional cytopenias with plausible explanations for example, pre-regenerative anemia in the face of acute hemorrhage or hemolysis or lymphopenia in an ill/stressed patient; ^dsampling of bone marrow by aspiration, core biopsy, or both, is undertaken; ^efor example, lymphoreticular neoplasia or feline immunodeficiency virus infection; ^fat least 2 of 4 parameters abnormal in addition to thrombocytopenia: prothrombin time (PT), activated partial thromboplastin time (aPTT), D-dimers > reference interval (RI); fibrinogen < RI; ^gPT or aPTT >25% control value; ^hpartial screening (ie, not exhaustive) for potential trigger factors undertaken and negative.

4.1.1 | In dogs/cats with confirmed thrombocytopenia (P), compared with platelet count alone (C) do platelet indices (eg, mean platelet volume [MPV], immature platelet fraction [IPF], reticulated platelets, plateletcrit) (E) improve differentiation of ITP from non-immune thrombocytopenia (O)?

Guidelines (dogs)

- There is conflicting evidence regarding changes in MPV in dogs with ITP compared with other causes of thrombocytopenia or healthy dogs.
- In dogs with thrombocytopenia, increased reticulated platelets may help differentiate ITP from non-immune thrombocytopenia, but not between dogs with primary and secondary ITP.
- There is insufficient evidence to make recommendations regarding use of plateletcrit and IPF in the diagnosis of ITP in dogs.
- In thrombocytopenic dogs, use of plateletcrit, IPF, and MPV as routine diagnostic tests for primary ITP are not recommended.
- In thrombocytopenic dogs, we suggest that increased reticulated platelets (when measurement is available) can be considered to support a diagnosis of primary or secondary ITP.

Level of evidence (dogs): Low. Strength of recommendation: Weak.

Evidence summary (dogs)

Of the 21 observational studies in dogs reviewed for this PECO question, 14 studies with some relevance were identified, and none directly addressed the question.^{19,21,31-42}

Reticulated platelets

Of the available platelet indices, most evidence exists for use of reticulated platelets to distinguish primary ITP from non-immune thrombocytopenia, but overall, the evidence is weak. In a prospective cross-sectional study including 17 dogs with probable primary ITP, increased reticulated platelet percentage helped differentiate primary ITP from non-immune thrombocytopenia, whereas platelet count did not.¹⁹ In this study, a reticulated platelet threshold of 8% combined with PSAIG was sensitive (94.1%) but not specific (27.6%) for discriminating primary ITP from other causes of thrombocytopenia.¹⁹ However, neither platelet count nor percentage of reticulated platelets differentiated primary from secondary ITP.¹⁹ In another prospective cross-sectional study 36/45 (80%) thrombocytopenic dogs had increased reticulated platelets. All 6 dogs with ITP had increased reticulated platelets, but so did many other dogs with non-immune thrombocytopenia, and sub-groups were not directly compared.³¹ Smaller studies have observed increased reticulated platelets in dogs with ITP⁴¹ and thrombocytopenia in general.³² Reticulated platelets decrease when platelet counts increase,^{33,34} but do not correlate with bone marrow megakaryocyte numbers.³⁵

MPV

Seven studies evaluating MPV in ITP were reviewed with conflicting results.^{21,36-40,42} In dogs with ITP, both decreased to normal MPV^{21,42} and increased MPV have been observed.^{37,38} In a retrospective case

series of 83 thrombocytopenic dogs, those with ITP (primary and secondary combined, $n = 37$) and with primary ITP ($n = 17$) had lower MPV than dogs with non-immune thrombocytopenia.²¹ However, the diagnostic algorithm could not be completely applied to this study, decreasing diagnostic certainty.²¹ Most studies compared dogs with ITP to healthy controls rather than to dogs with non-immune thrombocytopenia.^{38,39} For example, a retrospective case-control study determined that dogs diagnosed with primary ITP ($n = 49$) have increased MPV compared with healthy control dogs ($n = 46$),³⁸ a finding corroborated by a retrospective cross-sectional study.³⁹ A retrospective case series of dogs with PSAIG showed that MPV was lower in dogs with primary ITP ($n = 21$) than in dogs with secondary ITP ($n = 24$).³⁶ In contrast, another case series described increased MPV in 4/5 dogs with primary ITP and low to normal MPV in dogs with secondary ITP.³⁷ Finally, a retrospective case series of 60 thrombocytopenic dogs observed that MPV was significantly associated with a bone marrow response, but did not assess the utility of MPV for differentiating the cause of thrombocytopenia.⁴⁰

Plateletcrit

No studies evaluating the use of plateletcrit or IPF for differentiating the cause of thrombocytopenia in dogs were identified. In a retrospective case-control study, plateletcrit was decreased in dogs with primary ITP compared with healthy control dogs, but no dogs with thrombocytopenia of other causes were assessed.³⁸

Link to diagnostic algorithm (Figure 2): Although not included in our systematic review, we recommend that identification of macrothrombocytes, particularly in healthy dogs lacking signs of a primary hemostatic defect and breeds, or mixed breeds, with hereditary macrothrombocytopenia, should prompt genetic testing early in the diagnostic evaluation.^{43,44}

Guidelines and evidence summary (cats)

See Supporting Information 11.

4.1.2 | In dogs or cats with primary ITP (P), do platelet indices (E) compared with platelet count alone (C) impact predictions of disease severity, including bleeding risk, blood product requirement, hospitalization duration, time to platelet recovery, response to first-line treatment, survival, or relapse (O)?

Guidelines (dogs)

- In dogs with primary ITP, there is weak evidence to suggest that plateletcrit as opposed to platelet count is more sensitive to platelet recovery.
- In dogs with primary ITP, there is insufficient evidence to assess the utility of MPV, reticulated platelets, or IPF for prediction of bleeding severity, duration of hospitalization, blood product requirement, or platelet count recovery.
- In dogs with primary ITP, use of MPV, reticulated platelets, and IPF as routine prognostic tools is not recommended.

- d. We suggest that serial plateletcrits be considered as adjunctive parameters to platelet counts in assessing response to treatment in dogs with ITP.

Level of evidence (dogs): Low. Strength of recommendation: Weak.

Evidence summary (dogs)

No studies were identified that directly assessed platelet indices as severity metrics, but 3 studies provided indirect information.^{34,38,45} One retrospective case-control study observed that in dogs with primary ITP ($n = 49$) plateletcrit increased before platelet count,³⁸ but did not compare the prognostic value of platelet count and plateletcrit values. Two single case reports suggested that increased reticulated platelet percentage at the time of diagnosis might be associated with treatment response, but confirmatory evidence is lacking.^{34,45}

Guidelines and evidence summary (cats)

See Supporting Information 11.

4.2.1 | In dogs/cats with confirmed thrombocytopenia (P), does severe thrombocytopenia (E) compared with mild to moderate thrombocytopenia (C), improve differentiation of ITP from non-immune thrombocytopenia (O)?

Guidelines (dogs)

- Most evidence suggests that dogs with ITP have more severe thrombocytopenia compared with non-immune causes of thrombocytopenia, but there is overlap between diagnostic groups.
- In dogs with thrombocytopenia, evaluation of the severity of thrombocytopenia may help differentiate ITP from non-immune thrombocytopenia.
- We suggest that a platelet count $<20\,000/\mu\text{L}$ supports a diagnosis of ITP in dogs but is insufficient to independently make such a diagnosis.

Level of evidence (dogs): Moderate. Strength of recommendation: Moderate.

Evidence summary (dogs)

Five studies were identified that suggest thrombocytopenia severity has diagnostic relevance.^{21,22,36,46,47} Two were prospective,^{22,46} but did not specifically address the PECO question. In 4 studies, dogs with primary ITP had more severe thrombocytopenia than dogs with non-immune thrombocytopenia.^{21,22,46,47} In 3 studies, dogs with primary ITP had more severe thrombocytopenia than dogs with secondary ITP.^{21,22,36} In all 5 studies, platelet counts overlapped between groups, precluding use of platelet count alone for primary ITP diagnosis, but suggesting platelet count may aid diagnosis when combined with other data. One retrospective study reported that thrombocytopenia $<20\,000/\mu\text{L}$ was consistent with ITP, particularly when accompanied by decreased MPV. However, a cutoff of $40\,000$ platelets/ μL was not discriminating for ITP.⁴²

Two opposing studies were identified. In 1 retrospective study, dogs with ITP and disseminated intravascular coagulation (DIC) had lower platelet counts than dogs with thrombocytopenia from other causes, but thrombocytopenia severity was not discriminating.⁴⁸ Another retrospective study of dogs with thrombocytopenia observed only mild thrombocytopenia ($78\,000$ – $125\,000/\mu\text{L}$) in dogs with ITP,⁴⁹ whereas dogs with DIC and other non-immune causes of thrombocytopenia had lower platelet counts. Statistical comparisons were not performed.

Most studies evaluated were retrospective,^{21,36,42,47–49} many lacked long-term follow-up, and some were hampered by case selection bias precluding strong recommendations. Overall, the available evidence suggests that severe thrombocytopenia compared with mild or moderate thrombocytopenia may help differentiate ITP from other causes of thrombocytopenia, but platelet count cannot be used as the sole criterion.

Guidelines (cats)

- There is weak evidence suggesting that cats with ITP have more severe thrombocytopenia compared with those with non-immune causes of thrombocytopenia.
- In cats with thrombocytopenia, evaluation of the severity of thrombocytopenia may help differentiate ITP from non-immune thrombocytopenia.
- We suggest that a platelet count $<20\,000/\mu\text{L}$ supports a diagnosis of ITP in cats but is insufficient to independently make such a diagnosis.

Level of evidence (cats): Low. Strength of recommendation: Weak.

Evidence summary (cats)

No studies were identified that directly addressed the PECO question, but 4 studies provided indirect and weakly supportive evidence.^{4,5,50,51} A retrospective study of 194 cats with thrombocytopenia observed that cats with probable primary ITP had the most severe thrombocytopenia, but platelet counts $<50\,000/\mu\text{L}$ also were seen in cats with neoplasia, infection, bone marrow disease, or traumatic hemorrhage.⁵⁰ Bone marrow disease was the most common cause of platelet counts $<50\,000/\mu\text{L}$.⁵⁰ A retrospective study of thrombocytopenia in 41 cats identified 1 case of primary ITP, but insufficient information was provided to apply the diagnostic algorithm. This cat had 1 of the lowest platelet counts in the study, but the result was similar to those found in infectious causes of thrombocytopenia.⁵¹ In a case series of 4 cats with confirmed primary ITP, all had platelet counts $<20\,000/\mu\text{L}$ at diagnosis.⁵ Similarly, in 5 cats with confirmed primary ITP, observed platelet counts ranged from 4 to $46\,000/\mu\text{L}$.⁴

Link to diagnostic algorithms (Figures 2 and 3): Our diagnostic algorithm begins with a confirmed platelet count of $<100\,000/\mu\text{L}$, consistent with ITP definitions in human medicine, and a relevant threshold for likely ITP diagnoses in animals.⁵² Some animals with ITP may have higher platelet counts at diagnosis, but this threshold increases the likelihood of an ITP diagnosis. Humans with mild thrombocytopenia ($100\,000$ – $150\,000/\mu\text{L}$) have only a 6.9% 10-year probability of developing more severe thrombocytopenia.⁵³

4.2.2 | In dogs/cats with primary ITP (P), does severe thrombocytopenia (E) compared with mild to moderate thrombocytopenia (C) impact prediction of bleeding severity, response to first line treatment, relapse, survival, hospitalization duration, blood product requirement, or time to platelet count recovery (O)?

Guidelines (dogs)

- In dogs with primary ITP with *moderate to severe* thrombocytopenia (platelet count $<50\,000/\mu\text{L}$), there is moderate evidence to suggest that admission platelet count does not impact disease outcome or response to treatment but may be related to signs of hemorrhage at presentation.
- In dogs with primary ITP with *moderate to severe* thrombocytopenia (platelet count $<50\,000/\mu\text{L}$), we suggest that admission platelet count alone should not be employed to predict disease outcome or guide treatment.
- No studies were identified that compared outcomes in dogs with primary ITP with mild (platelet count $>75\,000/\mu\text{L}$) versus moderate to severe thrombocytopenia (platelet count $<50\,000/\mu\text{L}$).

Level of evidence (dogs): Moderate. Strength of recommendation: Moderate.

Evidence summary (dogs)

One prospective observational study was identified that addressed the PECO question, but was considered neutral because all dogs diagnosed with primary ITP had platelet counts $<50\,000/\mu\text{L}$.²² Platelet count and bleeding severity score (DOGiBAT bleeding assessment tool) were negatively correlated in dogs with primary ITP, suggesting a relationship between these variables, but platelet count was not associated with blood product administration, duration of hospitalization, or survival to discharge.

Five studies indirectly addressed the PECO question and were considered opposed to it.^{46,54-57} In a prospective cross-sectional study of 28 dogs with immunologically confirmed ITP and thrombocytopenia $\leq 60\,000/\mu\text{L}$, admission platelet count did not predict treatment response.⁴⁶ A retrospective cohort study of 73 dogs with probable primary ITP and thrombocytopenia $<50\,000/\mu\text{L}$ observed that dogs with melena had decreased survival and higher transfusion requirements than those without melena.⁵⁴ Platelet counts were similar between dogs with and without melena, suggesting that platelet count did not impact bleeding severity. Furthermore, the initial platelet count and lowest recorded platelet count were not associated with survival to discharge.⁵⁴ A prospective study evaluating the use of vincristine in 24 dogs with probable primary ITP and thrombocytopenia $<15\,000/\mu\text{L}$ did not observe a relationship between initial platelet count and time for platelet count recovery.⁵⁵ A retrospective case series of 65 dogs with probable primary ITP and thrombocytopenia $<40\,000/\mu\text{L}$ determined that platelet count at admission did not differ between dogs that relapsed and those that did not.⁵⁶ Likewise, a retrospective case series of 15 dogs with ITP

and thrombocytopenia $<50\,000/\mu\text{L}$ also found no relationship between initial platelet count and relapse.⁵⁷

Two studies were reviewed that described more bleeding in dogs with severe thrombocytopenia but did not rigorously address patient outcomes related to platelet count. In 1 retrospective case series of 30 dogs with probable primary ITP with immunologic confirmation, thrombocytopenia $<30\,000/\mu\text{L}$ was positively correlated with spontaneous bleeding.³ Most dogs in the study had thrombocytopenia $<30\,000/\mu\text{L}$, but some had platelet counts up to $110\,000/\mu\text{L}$. All dogs that received transfusions had thrombocytopenia $\leq 20\,000/\mu\text{L}$.³ In another retrospective case series of 54 dogs with possible primary ITP, all dogs with bleeding had platelet counts $\leq 30\,000/\mu\text{L}$ and 80% of bleeding dogs had platelet counts $\leq 10\,000/\mu\text{L}$,⁵⁸ but the range of platelet counts was not reported.⁵⁸

Prospective studies with standardized treatment that assess the association between thrombocytopenia severity and outcome are lacking. It is possible that dogs with severe thrombocytopenia were treated more aggressively in the reviewed studies, masking an impact of platelet count on disease outcome.

Guidelines and evidence summary (cats)

See Supporting Information 11.

4.3.1 | In dogs/cats with confirmed thrombocytopenia (P), compared with platelet count alone (C) does the addition of bone marrow examination (E) help differentiate ITP from non-immune thrombocytopenia (O)?

Guidelines (dogs)

- There is insufficient evidence to determine whether bone marrow examination improves the diagnosis of primary ITP in dogs.
- Bone marrow examination is not recommended as a routine diagnostic test for primary ITP in dogs.
- We suggest that bone marrow examination be considered to characterize ill-defined cytopenias, recognizing that there is no bone marrow abnormality diagnostic for primary ITP.

Level of evidence (dogs): Low. Strength of recommendation: Weak.

Evidence summary (dogs)

No studies were identified that directly addressed the PECO question. Several case reports and case series described bone marrow examination in dogs with thrombocytopenia. In a study of 55 dogs with thrombocytopenia that underwent bone marrow examinations, diagnostically relevant cytologic abnormalities were less common in dogs with platelet counts $<20\,000/\mu\text{L}$ compared with platelet counts between $20\,000$ and $200\,000/\mu\text{L}$.⁵⁹ However, causes of thrombocytopenia were not differentiated. Megakaryocytic hyperplasia, hypoplasia, and normal megakaryocyte numbers all are described in dogs with ITP,^{21,54,58,60,61} but these studies did not analyze or compare bone

marrow findings between dogs with ITP and those with non-immune causes of thrombocytopenia.

Guidelines and evidence summary (cats)

See Supporting Information 11.

Link to diagnostic algorithms (Figures 2 and 3): Bone marrow evaluation is only recommended if otherwise unexplained additional cytopenias are present, consistent with current American Society of Hematology guidelines.⁶²

4.3.2 | In dogs/cats with primary ITP (P) does bone marrow evaluation (E) compared with platelet count alone (C) improve prediction of bleeding severity, response to first-line therapy, survival, blood product requirement, duration of hospitalization, days to platelet recovery, or ITP relapse (O)?

Guidelines (dogs)

- Available evidence is contradictory regarding the utility of megakaryocyte hypoplasia for prediction of disease severity in dogs with primary ITP.
- In dogs with primary ITP, bone marrow examination is not recommended as a routine prognostic tool.

Level of evidence (dogs): Low. Strength of recommendation: Weak.

Evidence summary (dogs)

No studies were identified that directly addressed the PECO question. In a retrospective case series of 34 dogs with primary ITP, anemia, clinical bleeding, transfusion, and poor survival were associated with megakaryocytic hypoplasia or dysplasia (no statistical analysis performed).⁶³ In 2 case reports, dogs with primary ITP and megakaryocytic hypoplasia had clinical bleeding and delayed responses to treatment.^{64,65} In contrast, a retrospective cohort study of 73 dogs with probable primary ITP that included 11 dogs with bone marrow examination found no relationship between megakaryocyte hypoplasia and days to platelet recovery, or survival to discharge.⁵⁴ A case series of dogs with thrombocytopenia, including 13 dogs with primary ITP, found that 10 had clinical signs of bleeding, and all 9 dogs with bone marrow evaluation had megakaryocytic hyperplasia but how many of those dogs experienced bleeding was not stated.²¹ Finally, all 7 dogs with megakaryocyte hypoplasia survived to discharge in a case series of dogs with thrombocytopenia that included primary ITP cases.⁵⁹ Some evidence suggests that megakaryocyte hypoplasia may be related to more severe disease, but contradictory evidence on megakaryocyte response also exists; hence, the prognostic value of bone marrow examination could not be determined.

Guidelines and evidence summary (cats)

See Supporting Information 11.

4.4.1 | In dogs/cats with confirmed thrombocytopenia (P), compared with platelet count alone (C) do platelet/megakaryocyte-associated antibody assays (E) help differentiate ITP from non-immune thrombocytopenia (O)?

Guidelines (dogs)

- We suggest that in thrombocytopenic dogs, positive platelet/megakaryocyte-associated antibody tests indicate that an immune component is contributing to thrombocytopenia but are not diagnostic for ITP.
- In dogs with thrombocytopenia, routine measurement of platelet/megakaryocyte-associated antibodies is not recommended.

Level of evidence (dogs): Low. Strength of recommendation: Weak.

Evidence summary (dogs)

Eighteen studies were reviewed that employed platelet or megakaryocyte antibody testing, all neutral to the PECO question.^{19-21,32,36,41,46,66-76} In total, the evidence suggests that the presence of PSAIG indicates an immune component to the thrombocytopenia, but is not diagnostic for ITP.

One prospective cross-sectional study describing a direct radioimmunoassay presented sufficient data to allow calculation of assay diagnostic metrics.²⁰ The PSAIG radioimmunoassay and platelet count <40 000/μL performed similarly for primary ITP diagnosis (Table 1). The PSAIG assay did not reliably differentiate ITP from non-immune causes of thrombocytopenia because 9/17 dogs with non-immune thrombocytopenia had PSAIG concentrations above the cut-off.²⁰ It was also possible to calculate the positive predictive value (PPV) of PSAIG and platelet count from a retrospective case series,²¹ with both PSAIG and platelet count <20 000/μL performing similarly (Table 1). Although 12/13 dogs with ITP were PSAIG-positive, dogs with non-immune causes similarly were positive.²¹ Diagnostic data provided were inconsistent, precluding application of the diagnostic algorithm. These studies provide weak evidence suggesting that PSAIG and platelet count perform similarly for differentiating ITP from non-immune thrombocytopenia.

A prospective cross-sectional study provided information regarding the diagnostic utility of a flow cytometric PSAIG assay, but did not compare assay utility with platelet count.¹⁹ The study of 115 dogs, 17 of which had probable primary ITP, reported moderate sensitivities and specificities (Table 1).¹⁹ When dogs with ITP (primary and secondary) were compared with those with non-immune causes, there was no difference in percentage of direct or indirect IgG, direct or indirect IgM, and direct and indirect IgG/IgM combined.¹⁹ However, direct and indirect IgG combined were higher in dogs with ITP compared with dogs with non-immune thrombocytopenia.¹⁹ Another prospective cross-sectional study similarly found no difference in PSAIG between dogs with primary ITP and those with non-immune thrombocytopenia.⁷¹ Several other studies also

TABLE 1 Diagnostic performance of various assays for platelet surface-associated immunoglobulins (PSAIG).

Study	PSAIG assay	Metric	Primary ITP vs other causes of thrombocytopenia				ITP (primary and secondary) vs non-immune thrombocytopenia	
			Sens	Spec	PPV	NPV	Sens	Spec
Bachman et al ¹⁹	Flow cytometry	Direct IgG	29%	76%	28%	79%		
		Direct/indirect IgM or IgG	77%	66%				
		Direct/indirect IgG					46%	71%
Scott et al ²⁰	Radioimmunoassay	PSAIG	100%	47%	72%	100%		
		PLT <40 K/ μ L	96%	76%	85%	93%		
Dircks et al ²¹	Flow cytometry	PSAIG			32%			
		PLT <20 K/ μ L			34%			

Abbreviations: ITP, immune thrombocytopenia; NPV, negative predictive value; PLT, platelet count; PPV, positive predictive value; PSAIG, platelet surface-associated immunoglobulin; Sens, sensitivity; Spec, specificity.

suggest that PSAIG do not reliably differentiate primary from secondary ITP.^{41,46,68,71}

Fourteen additional studies were assessed, including 11 observational, cross-sectional studies; 2 retrospective case series; and 1 experimental study (total $n = 709$ dogs; 275 ITP dogs; 208 primary ITP dogs).^{32,41,46,66-70,72-76} None of these studies directly compared PSAIG assays with platelet count for differentiating ITP from non-immune thrombocytopenia. Additionally, in many of these studies, the presence of PSAIG was a criterion for a diagnosis of ITP, limiting assessments of assay diagnostic performance. Regardless, studies that report diagnostic performance data consistently suggest that direct PSAIG assays are sensitive (median, 94%; range, 29.4%-100%), but less specific (median, 75.9%; range, 47%-100%) for differentiating ITP from non-immune thrombocytopenia, with low to moderate PPV (median, 48%; range, 28%-72%) and moderate to very good negative predictive value (NPV; median, 100%; range, 79%-100%) for ITP.

Only 2 studies provided data on megakaryocyte-associated antibody assays for ITP diagnosis, but included no concurrent platelet count data.^{67,72} Consequently, there is insufficient information to assess the utility of megakaryocyte-associated antibody assays for ITP diagnosis.

Guidelines and evidence summary (cats)

See Supporting Information 11.

Link to diagnostic algorithms (Figures 2 and 3): The panel considered immunologic testing as supportive evidence for an immune component to platelet destruction but platelet/megakaryocyte antibody testing is not required for a diagnosis of ITP, consistent with current American Society of Hematology guidelines.⁶²

Lack of consensus: The 13/14 evidence evaluators agreed with guideline 4.4.1, whereas 1/14 stated that PSAIG assays should be performed if available.

4.4.2 | In dogs/cats with primary ITP (P), do platelet or megakaryocyte-associated antibody determinations (E) compared with platelet count alone (C) impact prediction of bleeding severity, response to first-line treatment, relapse, survival, hospitalization duration, blood product requirement, or time to platelet count recovery (O)?

Guidelines (dogs)

- In dogs with primary ITP, evaluation of platelet/megakaryocyte-associated antibodies for outcome prediction is not recommended.
- In dogs with primary ITP, we suggest that serial monitoring of platelet/megakaryocyte-associated antibodies might help identify disease relapse.

Level of evidence (dogs): Low. Strength of recommendation: Weak.

Evidence summary (dogs)

One prospective cross-sectional study was identified that directly assessed the PECO question. The study evaluated whether the magnitude of PSAIG measured using a flow cytometric assay influenced the following disease outcomes: (a) response to initial treatment, (b) survival to hospital discharge, and (c) relapse.⁴⁶ The study described 28 dogs with primary ITP and reported that neither the initial percentage of PSAIG-positive platelets nor initial platelet count discriminated for response to initial treatment or survival to hospital discharge.⁴⁶ Changes in PSAIG positivity and platelet count for the first 4 weeks of treatment did not predict response to treatment at 6 weeks.⁴⁶ These comparisons provide evidence that neither initial magnitude of PSAIG positivity nor initial platelet count predict response to initial treatment or survival to discharge. However, for dogs with primary ITP that entered remission, recurrence of PSAIG positivity was associated with relapse in 2 dogs.⁴⁶

Two studies indirectly assessed bleeding and presence of PSAIG, but not all dogs had primary ITP.^{21,72} One retrospective case series

found more bleeding in dogs with PSAIG, but statistical analyses were only performed for all causes of thrombocytopenia.²¹ An additional 4 studies were reviewed: 2 observational, cross-sectional studies and 2 retrospective case series (total n = 252 dogs; 203 ITP dogs; 91 primary ITP dogs). None presented data allowing comparison of autoantibody detection with platelet count for any PECO severity metric.^{3,20,36,77}

Overall, weak evidence suggests that platelet/megakaryocyte-associated antibody assays are equally ineffective as initial platelet count for prediction of response to initial treatment and survival to hospital discharge. There is weak evidence that recurrence of PSAIG positivity is associated with ITP relapse. There is insufficient information in the reviewed literature to assess the potential of platelet/megakaryocyte-associated antibody to predict bleeding severity, duration of hospitalization, blood product requirement, and platelet count recovery in dogs with primary ITP.

Guidelines and evidence summary (cats)

See Supporting Information 11.

4.5.1 | In dogs/cats with confirmed thrombocytopenia (P), compared with platelet count alone (C) does the addition of hemostasis testing (eg, coagulation testing, platelet function testing, viscoelastic testing, fibrinolysis testing, D-dimer concentration) (E) help differentiate ITP from non-immune thrombocytopenia (O)?

Guidelines (dogs)

- In dogs with thrombocytopenia, we recommend performing coagulation testing (activated partial thromboplastin time and prothrombin time) during the routine diagnostic evaluation.
- In dogs with thrombocytopenia, measurement of fibrinolysis markers (fibrin degradation products [FDP], D-dimer) should be considered.

Level of evidence (dogs): Moderate. Strength of recommendation: Strong.

Evidence summary (dogs)

Five observational studies or retrospective cases series reported coagulation testing in dogs with thrombocytopenia.^{49,76,78-80} Overall, these studies support the use of coagulation testing to differentiate patients with consumptive and toxic coagulopathies from patients with primary ITP. Coagulation testing aided identification of dogs with thrombocytopenia associated with disseminated intravascular coagulation (DIC) and anticoagulant rodenticide ingestion.^{49,76,78,80} Limited data support the use of fibrinolysis markers (eg, D-dimer) because these markers were inconsistently measured. One study described decreased platelet aggregation in dogs with ITP, but no comparisons were made with non-immune thrombocytopenia, precluding any determination of diagnostic utility.⁷⁹

Guidelines (cats)

- In thrombocytopenic cats, we recommend performing coagulation testing (activated partial thromboplastin time [aPTT] and prothrombin time [PT]) during the routine diagnostic evaluation.
- In thrombocytopenic cats, measurement of fibrinolysis markers (eg, FDP, D-dimer) should be considered.

Level of evidence (cats): Moderate. Strength of recommendation: Strong.

Evidence summary (cats)

Five retrospective cases series or case reports describing cats with thrombocytopenia were reviewed.^{51,81-84} These reports support the use of coagulation testing to differentiate cats with primary ITP from other systemic disorders associated with thrombocytopenia. In a case series of 85 ill cats, thrombocytopenia was present in 34%, and in 58% of cats with coagulation abnormalities,⁸⁴ whereas a second case series of cats with thrombocytopenia identified only 1 cat with primary ITP.⁵¹ Thrombocytopenia was present in 50% of cats with DIC in 1 case series. Prolongation of the aPTT was present in all DIC cats, whereas additional tests (eg, FDP, antithrombin) were useful to further characterize DIC.⁸¹ A case series of 69 cats with at least 1 abnormal hemostasis test result indicated that thrombocytopenia was present in 57% of cats with DIC, with neoplasia, liver failure, and feline infectious peritonitis being the most common inciting diseases.⁸³ One case report described the use of thrombelastography to characterize a bleeding diathesis in a cat with thrombocytopenia, but the cause was not determined.⁸²

Link to diagnostic algorithms (Figures 2 and 3): The panel integrated coagulation testing early in the diagnostic algorithm to rule out consumptive causes of thrombocytopenia before undertaking additional investigation.

Lack of consensus: While 13/14 evidence evaluators agreed with guideline 4.5.1 in dogs, 1/14 suggested that ITP dogs with severe melena can have mildly increased aPTT, D-dimers and FDP. Although 13/14 evidence evaluators agreed with guideline 4.5.1 in cats, 1/14 felt the literature insufficiently supported the recommendation.

4.5.2 | In dogs/cats with primary ITP (P), compared with determination of platelet count alone (C) does determination of bleeding severity score (E) improve prediction of bleeding severity, response to first-line treatment, survival, blood product requirement, duration of hospitalization, days to platelet recovery, or ITP relapse (O)?

Guidelines (dogs)

- In dogs with primary ITP, we recommend severity scoring be performed to aid assessment of disease severity.

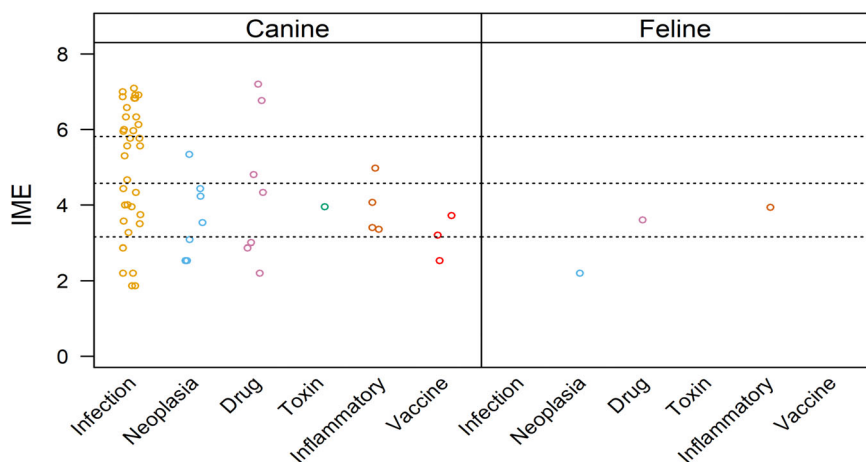


FIGURE 4 Summary of evidence for the causal role of comorbidities as a trigger for ITP in dogs and cats. Level of evidence for a specific comorbidity as a cause of ITP was assessed by means of a published *Integrated Metric of Evidence* (IME) value, which captures information on study design, quality of reporting, confidence of comorbidity diagnosis, likelihood of a causal link between the comorbidity and ITP, confidence of the ITP diagnosis, and the number of patients with a given comorbidity (excluding those patients with more than 1 comorbidity). Horizontal dotted lines indicate threshold IME values between negligible and low (3.15), low and intermediate (4.57), and intermediate and high (5.81) levels of evidence based on predetermined hypothetical thresholds (Supporting Information 8). An IME value of 0 indicates that the study directly demonstrated a lack of evidence that a comorbidity caused ITP.

Level of evidence (dogs): Moderate. Strength of recommendation: Moderate.

Evidence summary (dogs)

Five studies relevant to the PECO question were reviewed.^{22,46,54,63,85} Evidence from cohort studies indicates an association between severity score or anatomic site of bleeding with transfusion requirement, duration of hospitalization, or survival. In a cohort study of 34 dogs with primary ITP, a bleeding severity score (DOGiBAT bleeding assessment tool) directly correlated with transfusion requirement and duration of hospitalization, whereas platelet count was not associated with these metrics.²² In a retrospective study including 73 dogs with probable primary ITP,⁵⁴ and a prospective study with 28 primary ITP cases,⁴⁶ the presence of melena was associated with poor survival. Gastrointestinal bleeding is a component of the DOGiBAT bleeding assessment tool score.²²

Guidelines and evidence summary (cats)

See Supporting Information 11.

4.6.1 | In dogs/cats with primary ITP(P), compared with platelet count alone (C) do CBC or biochemistry panel abnormalities (E) improve prediction of bleeding severity, response to first-line treatment, survival, blood product requirement, duration of hospitalization, days to platelet recovery, or ITP relapse (O)?

Guidelines (dogs)

- In dogs with primary ITP, we recommend that CBC and biochemistry panels be performed to aid assessment of disease severity.

Level of evidence (dogs): Moderate. Strength of recommendation: Moderate.

Evidence summary (dogs)

Nine studies were reviewed, but none directly addressed the PECO question.^{3,21,37,54,56,58,63,86,87} Evidence from case reports and case series indicates that biochemistry panel abnormalities (high blood urea nitrogen concentration) and CBC abnormalities (low hematocrit) may be associated with increased disease severity in dogs with primary ITP. A retrospective study of 55 dogs with primary ITP found an association between high blood urea nitrogen concentration and poor survival.⁵⁴ An association between low hematocrit and transfusion was reported in 2 case series of dogs with primary ITP, but in 1 of these studies the most anemic dogs had amegakaryocytic thrombocytopenia.^{37,63} Other case series identified a variable association or did not evaluate the relationship between these variables and severity metrics.^{3,21,86,87} Thrombocytopenia severity was related to transfusion requirements or bleeding in 2 retrospective case series,^{3,58} but no assessments of other hematologic variables were described.

Guidelines and evidence summary (cats)

See Supporting Information 11.

5 | GUIDELINES FOR COMORBIDITY SCREENING IN ITP

The first part of this section summarizes the evidence for a causal role of various comorbidities in ITP; the second part presents guidelines for comorbidity screening based on the evidence accrued. Evidence summaries and guideline recommendations are presented for comorbidities

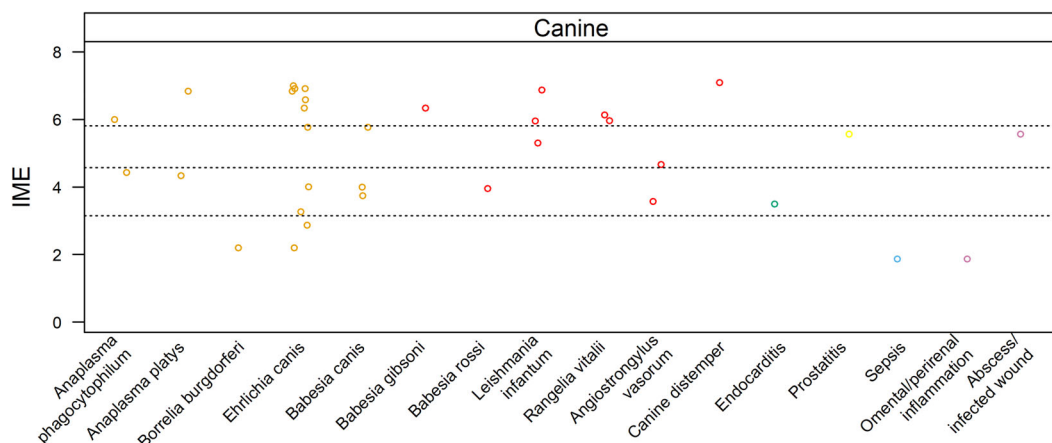


FIGURE 5 Summary of evidence for the causal role of infection as a trigger for ITP in dogs. Level of evidence for infection with a specific pathogen (or location/type of infection) as a cause of ITP was assessed by means of a published *Integrated Metric of Evidence* (IME) value. Horizontal dotted lines indicate threshold IME values between negligible and low (3.15), low and intermediate (4.57), and intermediate and high (5.81) levels of evidence based on predetermined thresholds (Supporting Information 8). An IME value of 0 indicates that the study directly demonstrated a lack of evidence that a comorbidity caused ITP.

represented by ≥ 1 study with a high level of evidence. The remainder, including all studies in cats, are included in Supporting Information 12.

Overall, 165 manuscripts met inclusion criteria for review (Supporting Information 1 and 3). Integrated metric of evidence values could be calculated for 59 comorbidities from 48 manuscripts (Figure 4, Supporting Information 10).^{41,61,70,73,76,78,85,88-128} For the remainder, IME values could not be calculated because the number of animals with ITP or the comorbidity could not be discerned, >1 comorbidity was present, ITP was ultimately deemed “unlikely” or “primary” based on the diagnostic algorithm, the diagnostic algorithm could not be applied, or patient data were already captured in another study.

5.1 | Infections

In humans, several infectious agents are associated with ITP, including *Helicobacter pylori*, *Plasmodium* spp., severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2), Hepatitis C Virus, and Human Immunodeficiency Virus.¹²⁹⁻¹³⁵ Evidence suggests that mechanisms of immune-mediated platelet destruction include molecular mimicry, immune-targeting of bound or expressed platelet antigens, and immune-complex binding of platelet FcγRIII receptors.^{129,132,133,136,137} Genetic and environmental factors that affect the host immune milieu, and genetic and phenotypic differences among strains of microorganisms, also influence whether ITP develops or not.^{129,132,136-138} In this study, IME values were calculated for 34 infections as potential causes of ITP in dogs and cats (Figure 5 and Supporting Information 10).

5.1.1 | Canine vector-borne infections

Ehrlichia spp.

Consensus summary statement

Overall, there is a high level of evidence that infection with *E. canis* causes ITP in dogs. Mechanisms in addition to immune-mediated

destruction contribute to thrombocytopenia. Further study is needed to determine whether species or strain differences, as well as host or environmental factors, contribute to the development of ITP.

Evidence summary

Twenty-seven studies were evaluated.^{3,21,61,70,74,85,93,95,97,100,103,104,107,114,116,117,123,139-148} Integrated metric of evidence values (median, 6.33; range, 2.2-7.0) were calculated for 11 studies.^{70,85,93,100,103,104,107,114,116,117,123} Of these 11 studies, evidence was negligible in 18% (2/11),^{85,93} low in 18% (2/11),^{114,116} intermediate in 9% (1/11),¹⁰⁷ and high in 50% (6/11)^{70,100,103,104,117,123} that infection with *E. canis* causes ITP in dogs. Integrated metric of evidence values could not be calculated for the remaining 16 studies.^{3,21,61,74,95,97,139-148}

Of the 11 studies with an IME value, 10 specifically studied *E. canis*.^{70,85,93,100,103,104,114,116,117,123} One study did not indicate the *Ehrlichia* species involved,¹⁰⁷ but *E. canis* was presumed based on geographic locale.¹⁴⁹ Overall, high level evidence suggests immune-mediated platelet destruction contributes to thrombocytopenia in dogs with ehrlichiosis. In 7 studies (median IME, 6.45; range, 3.27-7.00; $n = 50$) dogs were experimentally infected.^{70,100,103,104,114,117,123} PSAIG was demonstrated using flow cytometry in 4 of these studies.^{70,103,117,123} Because PSAIG was demonstrated in some dogs as early as day 7, it has been hypothesized they might represent naturally occurring autoantibodies.^{103,140} Of note, experimental infections involved infusing infected canine blood, which presumably contained platelets, into naïve recipients.

Levels of evidence varied for 4 additional studies that involved dogs naturally infected with *E. canis* (median IME, 3.22; range, 2.20-5.77; $n = 8$),^{85,93,107,116} including 2 case reports,^{93,116} 1 study comparing platelet transfusion products in which 1 dog was *E. canis*-seroreactive,⁸⁵ and 1 study documenting 5 dogs with severe thrombocytopenia and PSAIG.¹⁰⁷ An IME value could not be calculated for 1 additional study that included 7 *E. canis*-seroreactive dogs with thrombocytopenia and PSAIG.³

In addition to PSAIG, splenic sequestration and removal of platelets,¹⁰⁴ vasculitis, hypercoagulability, and myelosuppression all may contribute to thrombocytopenia in ehrlichiosis.^{70,150-152}

There were no studies of other species of *Ehrlichia* for which IME values could be calculated. In 1 study, no significant difference was found in mean platelet count for 3 dogs infected with *E. chaffeensis* compared with uninfected controls.¹⁴⁴ This finding contrasted with *E. canis*-infected dogs, in which platelet counts significantly decreased during the study. In a retrospective study of 41 dogs PCR-positive for *E. ewingii*, 16 were thrombocytopenic (range, 5-189 000 platelets/ μ L) and 2 were reported to have ITP, although the ITP diagnostic criteria were not described.¹⁴⁷

Leishmania spp.

Consensus summary statement

Overall, high-level evidence suggests that *Leishmania infantum* infection causes ITP in dogs. Mechanisms other than immune-mediated destruction also contribute to thrombocytopenia in dogs with leishmaniosis.

Evidence summary

Seven studies were evaluated.^{3,21,96,97,107,121,153} Integrated metric of evidence values of 5.30 to 6.87 (median 5.9) were calculated for 3 studies.^{96,97,121} Thirty-three percent (1/3)⁹⁷ of the studies demonstrated an intermediate level of evidence and 67% (2/3) demonstrated a high level of evidence that *Leishmania* causes ITP.^{96,121} In a study of 33 dogs naturally infected with *L. infantum* (IME, 5.95), platelet surface-associated IgM and IgG were detected by flow cytometry in 64% (21) of dogs.¹²¹ All 21 dogs had platelet surface-associated IgM, and 9 had both IgM and IgG. Platelet surface-associated immunoglobulin was demonstrated in 8 of 9 thrombocytopenic dogs and antibody presence was significantly associated with severity of illness. Three of the 9 thrombocytopenic dogs had platelet counts <100 000/ μ L. In a prospective case-control study (IME, 6.87) of naturally infected dogs,⁹⁶ PSAIG was documented by flow cytometry in 19/20 *Leishmania*-infected dogs with thrombocytopenia, 13/24 *Leishmania*-infected dogs with normal platelet counts, and 0/10 healthy controls. In *Leishmania*-infected dogs, the presence of PSAIG was significantly associated with thrombocytopenia, suggesting that immune-mediated platelet destruction contributes to thrombocytopenia. A third study (IME, 5.30) also suggested that leishmaniosis causes ITP.⁹⁷ This study investigated the prevalence of PSAIG in 10 dogs with leishmaniosis, 10 dogs with ehrlichiosis, 10 dogs coinfecting with *Ehrlichia* and *Leishmania*, and 10 control dogs.⁹⁷ Platelet surface-associated immunoglobulin was documented in 5/10 dogs with leishmaniosis, 6/10 dogs with ehrlichiosis, and 7/10 coinfecting dogs. Only 1 *Leishmania*-infected dog had a platelet count <100 000/ μ L; PSAIG was not detected in this dog (the "n" used in the IME calculation was based on this dog). For 4 additional studies, IME values could not be calculated because of coinfection, inadequate data, reported platelet counts >100 000/ μ L, and presence of pancytopenia.^{3,21,107,153} In addition to immune-mediated destruction, leishmaniosis in dogs may cause thrombocytopenia as a consequence of vasculitis, bleeding diatheses, and bone marrow infection.¹⁵⁴ In a mouse model of visceral

leishmaniosis, decreased thrombopoietin, decreased bone marrow megakaryocytic maturation, and increased splenic and hepatic removal of opsonized and desialylated platelets all contributed to thrombocytopenia.¹⁵⁵

Anaplasma spp.

Consensus summary statement

Overall, there is an intermediate level of evidence that *Anaplasma* spp. cause ITP in dogs. Immunologic mechanisms of platelet destruction were clearly documented only for *A. phagocytophilum*. Whether antibody-mediated platelet destruction occurs during *A. platys* infection is not known. Other mechanisms may contribute to the development of thrombocytopenia in dogs with anaplasmosis. Further study is needed to determine if species and strain differences, or host or environmental factors, affect whether ITP develops during infection.

Evidence summary

Eleven studies were evaluated for evidence that *Anaplasma* spp. cause ITP in dogs.^{21,46,88,90,94,100,117,144,148,156,157} Integrated metric of evidence values were calculated for 4 studies (median, 5.2; range, 4.34-6.83; n = 32).^{88,90,94,100} Fifty percent (2/4) demonstrated low-level evidence,^{88,90} and 50% (2/4) demonstrated high-level evidence^{94,100} that *Anaplasma* spp. cause ITP in dogs.

Two studies documented thrombocytopenia associated with *Anaplasma platys* infection.^{88,100} In dogs simultaneously or sequentially infected with *Ehrlichia canis* and *A. platys*, or either organism alone, (n = 6 per group), *A. platys* infection resulted in thrombocytopenia, particularly when combined with *E. canis*.¹⁰⁰ The IME value for non-coinfecting dogs was 6.83.¹⁰⁰ In a separate study, 3 dogs with thrombocytopenia were documented to be infected with *A. platys* using cytology and PCR (IME, 4.34).⁸⁸

Two additional studies documented thrombocytopenia in dogs infected with *A. phagocytophilum*.^{90,94} In a study of 63 dogs (IME, 6.0) PCR-positive for *A. phagocytophilum*, 54 (86%) were thrombocytopenic, including 21 classified as severe (<30 000/ μ L) and 21 classified as moderate (30 000-100 000/ μ L).⁹⁴ Thirty-six dogs were tested for PSAIG, of which 16 (44%) were positive. The platelet counts in these dogs ranged from 0 to 95 800/ μ L (median, 16 700/ μ L). A case report (IME, 4.43) described a dog actively infected with *A. phagocytophilum* with severe thrombocytopenia, PSAIG, IMHA, and polyarthritis.⁹⁰

Seven additional studies for which IME values could not be calculated documented thrombocytopenia in dogs with anaplasmosis.^{21,46,117,144,148,156,157} In a study of 18 dogs PCR-positive for *A. phagocytophilum*, 16 were thrombocytopenic.¹⁵⁶ Six of the 9 dogs tested were positive for PSAIG, suggesting an immune-mediated pathogenesis. An IME value could not be calculated for this study because the number of dogs with platelet counts <100 000/ μ L could not be determined. Another study documented thrombocytopenia after confirmed experimental infection of *A. platys* in 4 dogs and *A. phagocytophilum* in 3 dogs, but an IME value could not be calculated because the number of dogs that became thrombocytopenic after infection was not reported.¹⁴⁴

Piroplasms

Babesia spp.

Consensus summary statement

Overall, the evidence that *Babesia* spp. cause ITP is low, although indirect study design affected some IME values. Two studies showed intermediate and high levels of evidence, respectively, that *Babesia* spp. may cause ITP. Further study is required to determine whether there are species differences in the ability of *Babesia* spp. to induce immune-mediated platelet destruction. Mechanisms other than immune-mediated destruction also may contribute to thrombocytopenia in dogs with babesiosis.

Evidence summary

Fifteen studies were evaluated for evidence that *Babesia* spp. cause ITP in dogs.^{3,21,41,101,107,109,111,117,145,158-163} Integrated metric of evidence values could be calculated for 5 studies (median, 4.00; range, 3.74-6.33; $n = 56$).^{41,101,107,109,111} Sixty percent (3/5) provided low-level evidence,^{101,109,111} 20% (1/5) provided intermediate,¹⁰⁷ and 20% (1/5) provided high-level evidence.⁴¹ For *B. canis*, 3 studies had IME values of 3.74,¹¹¹ 4.00,¹⁰⁹ and 5.77¹⁰⁷ (for 1 of these studies, species was presumed based on geographic locale).^{107,149} A high level of evidence was provided by a study in which 4 dogs experimentally infected with *B. gibsoni* developed severe thrombocytopenia and PSAIG (IME, 6.33).⁴¹ One study of 24 dogs naturally infected with *B. rossi* provided low-level evidence that *B. rossi* causes ITP (IME, 3.95).¹⁰¹ This study did not assess whether platelet- or megakaryocyte-associated antibodies were present, but did find that infected dogs had significantly higher levels of platelet-leukocyte aggregates than uninfected dogs, suggesting that innate immunity mediates consumption of platelets during infection. Notably, *B. rossi* can cause DIC,¹⁰¹ suggesting that multiple mechanisms may contribute to thrombocytopenia in dogs with babesiosis. The 10 studies for which an IME value could not be calculated, and several other studies not captured by the search strategy, documented that thrombocytopenia is common in dogs infected with, or exposed to, many *Babesia* species.^{21,41,117,145,158-168}

Rangelia spp.

Consensus summary statement

Two available studies provide high-level evidence that *Rangelia* spp. cause ITP in dogs.

Evidence summary

Two studies were evaluated,^{99,112} and provided high-level evidence (IME, 5.97 and 6.13) that *Rangelia* causes ITP in dogs. In a study of dogs with naturally occurring *R. vitalli* infections diagnosed using light microscopy, infected dogs had lower platelet counts than uninfected controls ($34\,100 \pm 27\,918/\mu\text{L}$ versus $259\,900 \pm 61\,050/\mu\text{L}$) and more platelets with surface-associated IgM.⁹⁹ Another study demonstrated severe thrombocytopenia 10 and 20 days post-experimental infection, but did not test for PSAIG.¹¹² Mechanisms other than immune-mediated destruction also likely contribute to thrombocytopenia in rangeliiosis.¹¹²

Borrelia burgdorferi

See Supporting Information 12.

Rickettsia rickettsii

See Supporting Information 12.

Angiostrongylus vasorum

See Supporting Information 12.

5.1.2 | Canine viral infections

Canine distemper virus

Consensus summary statement

One study provided high-level evidence that canine distemper virus strain R252 causes ITP, potentially through phagocytosis of platelets with surface-bound virus-antibody immune complexes and decreased platelet production because of megakaryocyte infection with distemper virus. Further study is required to determine the occurrence and clinicopathological course of ITP after natural infections.

Evidence summary

A single study (IME, 7.09) documented ITP in 2 gnotobiotic dogs experimentally infected with canine distemper virus (strain R252).¹²⁶ Thrombocytopenia developed on day 1 post-infection and peaked on day 10. Platelet count recovery was observed without immunosuppressive or other treatment until the end of the study on day 15 post-infection. In the same study, 17 additional dogs were inoculated with distemper virus and similarly developed transient thrombocytopenia, albeit with platelet counts $>100\,000/\mu\text{L}$. These dogs were not included in the IME calculation. The study provided mechanistic insights and identified viral antigen and anti-virus IgG on platelet surfaces of infected dogs from day 7 post-infection using immunocytochemistry. Serum anti-virus IgM was detected by ELISA on days 8 and 9. Immune complex-mediated platelet phagocytosis by hepatic reticuloendothelial cells was demonstrated by electron microscopy from day 5. Immunocytochemistry identified viral megakaryocyte infection starting on day 8 post-infection. A second study of 987 dogs with thrombocytopenia described the finding of canine distemper inclusion bodies.⁴⁷ The study design did not allow evaluation of the magnitude of platelet counts or the distribution of underlying diseases and an IME value therefore was not calculated.

5.1.3 | Other infections in dogs

See Supporting Information 12

5.1.4 | Vector-borne infections in cats

See Supporting Information 12

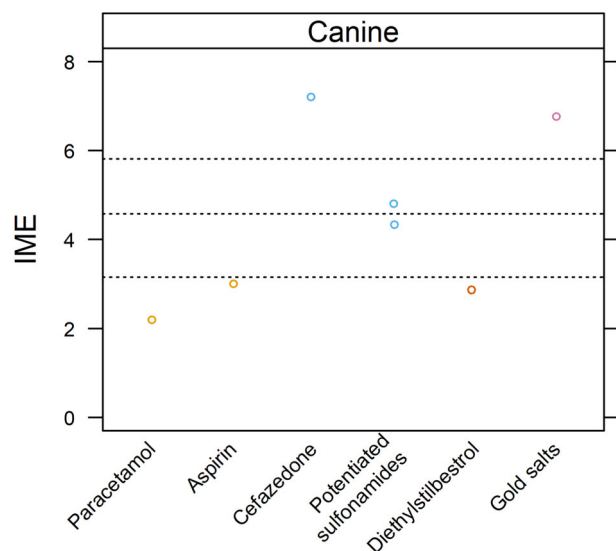


FIGURE 6 Summary of evidence for the causal role of drugs as a trigger for ITP in dogs. Level of evidence for drugs as a cause of ITP was assessed by means of a published *Integrated Metric of Evidence* (IME) value. Horizontal dotted lines indicate threshold IME values between negligible and low (3.15), low and intermediate (4.57), and intermediate and high (5.81) levels of evidence based on predetermined thresholds (Supporting Information 8). An IME value of 0 indicates that a study directly demonstrated a lack of evidence that a comorbidity caused ITP.

5.1.5 | Other infections in cats

See Supporting Information 12

5.2 | Drugs

Mechanisms of drug-induced ITP have been investigated extensively in human medicine.¹⁶⁹⁻¹⁷¹ Drug-induced immune dysregulation may result in both cellular and humoral immune targeting of platelets.¹⁷¹ Immune-mediated platelet destruction occurs when antibodies that target drug bound to platelet membranes or drug complexed with surface glycoproteins cause Fc-mediated phagocytosis or complement activation and platelet destruction. Destruction may also occur when drugs bind and cause a conformational change in the complementarity-determining region of specific antibodies allowing the antibody to target platelet glycoproteins.^{169,170,172} Drugs also can induce autoantibodies targeting platelets or megakaryocytes directly.^{169,172}

5.2.1 | Dogs

Overall, the evidence that drugs cause ITP in dogs is low, but high-level evidence suggests that cefazedone and gold salts, and intermediate-level evidence suggests that sulfonamide drugs, ITP. A lack of evidence for other drugs does not preclude the possibility of a drug-triggering ITP. Drug-induced ITP in dogs may be underreported.

Evidence summary

Twenty-four studies were evaluated.^{3,21,38,46,74,91,98,115,120,122,124,128,173-184} Integrated metric of evidence values were calculated for 7 drugs in 7 studies (median, 4.33; range, 2.20-7.20; Figure 6).^{91,98,115,120,122,124,128} Forty-three percent (3/7) demonstrated negligible,^{98,115,124} 14% (1/7) demonstrated low,¹²² 14% (1/7) demonstrated intermediate,¹²⁰ and 28% (2/7) demonstrated high^{91,128} levels of evidence that a drug caused ITP in dogs.

A high level of evidence for drug-induced ITP was found in 2 studies.^{91,128} In an experimental study (IME, 7.20) of high-dose (≥ 540 mg/kg/day) IV cefazedone given over 6 to 17 weeks, thrombocytopenia developed in 11/14 dogs.¹²⁸ Six of the 11 thrombocytopenic dogs had platelet counts $< 100\,000/\mu\text{L}$, all of which had PSAIG. Thrombocytopenia resolved after cessation of cefazedone in 1 dog and spontaneously resolved despite continued treatment in 2 dogs. In another experimental study (IME, 6.77) gold salt administration induced thrombocytopenia in 5/28 dogs after administration of PO auranofin or IM gold sodium thiomalate for 45 to 72 months.⁹¹ PSAIG was documented in 4 thrombocytopenic dogs, and platelet counts were $< 100\,000/\mu\text{L}$ in 4 dogs, 3 of which had PSAIG. Thrombocytopenia resolved in 3 dogs after withdrawal of gold salts and in 2 dogs in response to prednisolone. Platelet surface-associated immunoglobulin and platelet count were inversely correlated in 1 dog with relapsing ITP.

One case report yielded an intermediate IME value of 4.80.¹²⁰ Thrombocytopenia was documented in a dog treated for 7 days with trimethoprim/sulfadiazine, and thrombocytopenia resolved after the drug was discontinued. An immune-mediated mechanism was proposed since plasma from the treated dog caused fragmentation of healthy canine platelets.¹²⁰

The remaining reported cases were associated with low or negligible evidence supporting drug-induced ITP in dogs.^{98,115,122,124} In one case report (IME 4.33), thrombocytopenia, protein-losing nephropathy, lymphadenopathy, and polyarthritis were documented after administration of sulfadimethoxine/ormetoprim that resolved rapidly upon drug discontinuation.¹²² In another case report (IME, 3.00), a dog was treated with aspirin at 10 mg/kg PO q8h for 3 weeks, then at 10 mg/kg PO q24h, before developing IMHA with thrombocytopenia.¹²⁴ The dog improved with immunosuppression but subsequently was euthanized because of dyspnea. Another case report (IME, 2.87) described a dog that received diethylstilbestrol (2.5 mg/kg weekly) for 3 to 4 years that developed severe thrombocytopenia.⁹⁸ In a case report of a dog with IMHA and severe thrombocytopenia after acetaminophen administration (IME, 2.20), the thrombocytopenia resolved rapidly after acetaminophen discontinuation and an unspecified dose of prednisolone.¹¹⁵

For 17 studies, IME values could not be calculated because of the administration of multiple drugs, presence of multiple comorbidities, incomplete data reporting, or an inability to apply ITP diagnostic criteria.^{3,21,38,46,74,120,173-184} One study explored an immune-mediated mechanism for sulfonamide-induced ITP and documented PSAIG in 19/21 dogs.¹⁷⁹ All 11 thrombocytopenic dogs with clinical bleeding had documented PSAIG. However, thrombocytopenia was defined as $< 175\,000$ platelets/ μL , and individual values were not reported, precluding calculation of an IME value.

5.2.2 | Cats

See Supporting Information [12](#)

5.3 | Cancer

See Supporting Information [12](#)

5.4 | Vaccination

See Supporting Information [12](#)

5.5 | Toxins

See Supporting Information [12](#)

5.6 | Inflammatory Disease

See Supporting Information [12](#)

6 | CONSENSUS SCREENING RECOMMENDATIONS

6.1 | Global screening recommendations for dogs and cats

Testing should be performed according to the diagnostic algorithm (Figures [2](#) and [3](#)) and the written recommendations presented in the preceding sections to confirm that consumption, sequestration, or bone marrow disease (other than that affecting megakaryocytes because of ITP) are not the sole cause of thrombocytopenia.

To differentiate primary from secondary ITP, a thorough history documenting vaccinations, drugs, toxins, travel, exposure to fleas, ticks and other vectors, flea and tick prevention, and heartworm testing and prevention is recommended. A thorough physical examination including retinal examination and examination of the skin, lymph nodes, joints, bones, digital examination of the rectum, and in male dogs, the prostate gland, should be performed. Laboratory screening should include a CBC with blood film examination by a board-certified clinical pathologist (or equivalently trained hematologist), serum biochemical panel, and routine urinalysis. Urine culture and fecal flotation with centrifugation also should be considered. Imaging and other diagnostic tests to screen for cancer and potential foci of inflammation or infection should be performed at the discretion of the attending clinician based on their likelihood in the individual animal. In intact male dogs, prostatic ultrasound examination should be considered.

6.2 | Specific screening recommendations for dogs

Dogs with suspected ITP should be specifically screened for infection with *Ehrlichia* spp., *Babesia* spp., and *Anaplasma* spp. using combined testing with serology and PCR. Repeat testing by means of PCR or convalescent serologic testing or both should be performed in all dogs originally testing negative but with a high risk of infection based on breed or exposure risk.^{[144,185-189](#)}

Dogs with suspected ITP and other signs of leishmaniosis living in or with a history of travel to enzootic areas, and at-risk breeds in non-enzootic areas, should be screened for leishmaniosis using microscopy, serology, PCR or some combination of these tests. Dogs with suspected ITP living in or traveling to enzootic areas should be screened for infection with *Rangelia* spp. using combined testing with microscopy and PCR. Repeat testing by means of PCR should be performed in all dogs originally testing negative but with a high risk of infection. In dogs with ITP living in or traveling to enzootic areas, and especially those with concurrent cardiopulmonary disease, screening for *Angiostrongylus vasorum* using fecal sedimentation, antigen assay, or additional testing such as tracheal lavage fluid cytologic examination and PCR can be considered.

Further study to determine how and if other vector-borne disease agents cause ITP is required before definitive screening recommendations can be made for additional organisms. However, screening for additional vector-borne pathogens should be considered in dogs with exposure risk and clinical abnormalities consistent with infection. Screening for canine distemper virus should be considered if dogs are non- or under-vaccinated, living in enzootic areas, and have clinical findings consistent with infection. Evidence of systemic (eg, endocarditis, leptospirosis) or focal infections identified during initial screening should be further investigated, and changes in platelet count in response to treatment monitored.

6.3 | Specific screening recommendations for cats

All sick cats should be tested for feline leukemia virus (FeLV) and feline immunodeficiency virus (FIV) infection, according to American Association of Feline Practitioners (AAFP) retrovirus management guidelines. Although the role of infections in the development of ITP is unclear, identifying infections with a minimum database of CBC, serum biochemical panel, urinalysis, imaging, and specific testing as appropriate for a given case context, is warranted in thrombocytopenic cats with suspected ITP given the implications of immunosuppression and the possible role of infection as a trigger for ITP in an individual cat. In cats with suspected ITP living in enzootic areas or with exposure risk, screening for *A. phagocytophilum*, *Ehrlichia* spp., and *B. felis* should be considered.

7 | LIMITATIONS

A limitation of the literature evaluated for both diagnostic and comorbidity components of this consensus statement is that platelet counts

were not universally or uniformly verified in the evaluated studies, such that the prevalence and magnitude of thrombocytopenia might have been overestimated. In addition, there was inherent subjectivity and therefore variability in how the diagnostic algorithm was applied by evidence evaluators and, for comorbidities, in evaluating study indirectness by evidence evaluators. For several PECO questions, the level of evidence for the use of a diagnostic test was “low” and the strength of recommendation was “weak.” Similarly, evidence that a comorbidity caused ITP was often “negligible” or “low.”

For some comorbidities, it is possible that mechanisms other than immune-mediated platelet destruction contributed to the magnitude of thrombocytopenia. For example, infections can cause decreased platelet production by targeting bone marrow or decreasing hepatic TPO production, platelet sequestration from vasculitis or splenomegaly, platelet consumption from DIC, or by causing platelet desialylation and removal.^{137,155,190} Applying the algorithm helped to determine whether these processes contributed to the thrombocytopenia, but the extent of their effects could not always be determined. This approach could have affected causation scores and overall IME values.

Many comorbidities were assigned low or negligible IME values because studies did not specifically address whether a comorbidity causes ITP (indirectness). These studies were designated as “Descriptive Association” for the study design (Supporting Information 9). Therefore, low or negligible IME values should not be interpreted as a lack of causation.

Finally, although some studies were designed to determine if a comorbidity caused ITP, IME values could not be calculated because of the way platelet counts were reported or inability to apply the diagnostic algorithm. When identified, these articles were captured in the evidence summaries and are reflected in the evidence summary statements and screening recommendations.

8 | FUTURE DIRECTIONS

Given the lack of available literature to answer many of the PECO questions, appropriately designed outcomes-based studies that directly ask and answer these questions are needed to make more robust guidelines for the diagnosis of ITP in dogs and cats. Additional platelet indices such as immature platelet fraction recently have been introduced to veterinary medicine and may have diagnostic and prognostic utility.¹⁹¹ Diagnostic guidelines regarding the utility of certain tests may be revised in the future based on the results of studies designed to answer the PECO questions.

Mechanistic studies investigating whether PSAIG causes FcγR dependent or independent clearance, the role of antibody-independent immune-mediated platelet destruction, and whether and how comorbidity or self-antigen is targeted by the immune system may help in the development of tests that definitively diagnose ITP and individualize treatment strategies. Similarly, future research may demonstrate, as it has in murine models and human patients, that the mechanism of platelet clearance varies with the platelet antigen being targeted, which may in turn impact the ideal treatment modality.¹⁹²

AUTHOR CONTRIBUTIONS

Dana N. LeVine, Linda Kidd and Oliver A. Garden are co-chairs on the consensus statement and share corresponding author status. Dana N. LeVine, Linda Kidd, Oliver A. Garden, Marjory B. Brooks, and Robert Goggs share first authorship. Marjory B. Brooks, Robert Goggs, Barbara Kohn, and Andrew J. Mackin are panel members on the consensus statement. Erin Eldermire, Yu-Mei Chang, Julie Allen, Peter W. Christopherson, Barbara Glanemann, Haruhiko Maruyama, Maria C. Naskou, Lise N. Nielsen, Sarah Shropshire, Austin K. Viall, Adam J. Birkenheuer, Marnin A. Forman, Andrew S. Hanzlicek, Kathrin F. Langner, Erin Lashnits, Katharine F. Lunn, Kelly M. Makielski, Xavier Roura, and Eva Spada are advisory task force members on the consensus statement.

AFFILIATIONS

¹Department of Clinical Sciences, College of Veterinary Medicine, Auburn University, Auburn, Alabama, USA

²Western University of Health Sciences College of Veterinary Medicine, Pomona, California, USA

³Zoetis Animal Health Diagnostics, Parsippany, New Jersey, USA

⁴School of Veterinary Medicine, Louisiana State University, Baton Rouge, Louisiana, USA

⁵Department of Population Medicine and Diagnostic Sciences, College of Veterinary Medicine, Cornell University, Ithaca, New York, USA

⁶Department of Clinical Sciences, College of Veterinary Medicine, Cornell University, Ithaca, New York, USA

⁷Clinic for Small Animals, Faculty of Veterinary Medicine, Freie Universität Berlin, Berlin, Germany

⁸College of Veterinary Medicine, Mississippi State University, Starkville, Mississippi, USA

⁹Flower-Sprecher Veterinary Library, College of Veterinary Medicine, Cornell University, Ithaca, New York, USA

¹⁰Department of Comparative Biomedical Sciences, Royal Veterinary College, London, UK

¹¹Veterinary Information Network, Davis, California, USA

¹²Department of Pathobiology, College of Veterinary Medicine, Auburn University, Auburn, Alabama, USA

¹³Department of Clinical Science and Services, Royal Veterinary College, University of London, London, UK

¹⁴Department of Veterinary Medicine, College of Bioresource Sciences, Nihon University, Chiyoda City, Japan

¹⁵Department of Veterinary Clinical Sciences, University of Copenhagen, Copenhagen, Denmark

¹⁶College of Veterinary Medicine and Biomedical Sciences, Colorado State University, Fort Collins, Colorado, USA

¹⁷Department of Pathology, Microbiology, and Immunology, School of Veterinary Medicine, University of California, Davis, Davis, California, USA

¹⁸College of Veterinary Medicine, North Carolina State University, Raleigh, North Carolina, USA

¹⁹Cornell University Veterinary Specialists, Stamford, Connecticut, USA

²⁰MiraVista Veterinary Diagnostics, Indianapolis, Indiana, USA

²¹Western Australian Veterinary Emergency and Specialty, Perth, Australia

²²School of Veterinary Medicine, University of Wisconsin, Madison, Wisconsin, USA

²³Axiom Veterinary Laboratories, Newton Abbot, Devon, UK

²⁴College of Veterinary Medicine, University of Minnesota, St Paul, Minnesota, USA

²⁵Hospital Clinic Veterinari, Universitat Autònoma de Barcelona, Bellaterra, Spain

²⁶Veterinary Transfusion Research Laboratory (REVLab), Department of Veterinary Medicine and Animal Sciences, University of Milan, Lodi, Italy

ACKNOWLEDGMENT

No funding was received for this study.

CONFLICT OF INTEREST DECLARATION

Dana LeVine has received relevant research funding from the American Kennel Club Canine Health Fund, BodeVet, Morris Animal Foundation, and Veterinary and Comparative Clinical Immunology Society (VCCIS) and honoraria for speaking engagements from the ACVIM Forum, ECVIM-CA Congress, ACVIM Advanced Continuing Education, CVMA, and ACVP/ACSPV, and CanWest, and is also a consultant for Cellphire Therapeutics; Linda Kidd was a Veterinary Field Specialist for Zoetis Diagnostics August 2022-July 2023, is an Associate Editor for the Journal of Veterinary Internal Medicine and has received speaking honoraria from the ACVIM and IDEXX; Oliver Garden has received relevant research funding from the Kennel Club (UK) and Okava Pharmaceuticals, and speaking honoraria from the ACVIM Forum, ECVIM-CA Congress, and ACVP/ACSPV Annual Meeting. He has served as a consultant for Okava Pharmaceuticals and is the President of the Veterinary & Comparative Clinical Immunology Society; Marjory Brooks has received relevant research funding from the American Kennel Club and honoraria for speaking engagements from ACVIM Advanced Continuing Education, University of North Carolina Chapel Hill Symposium of Hemostasis, and the Society of Toxicologic Pathology's Symposium; Robert Goggs has received relevant research funding from the American Kennel Club Canine Health Fund, Aurin Biotech, BodeVet, Morris Animal Foundation, and Okava Pharmaceuticals and honoraria for speaking engagements from ACVIM Forum, EVECC Congress, IVECCS, PacVet, UnisVet and VCCIS; Julie Allen has served as a member of the Zoetis IMAGYST advisory board since 2022; Austin Viall has received relevant research funding from Morris Animal Foundation and VCCIS and has received honoraria for speaking engagements at ECVIM-CA Congress, CanWest, CVMA, IVMA, and SDVMA; Erin Lashnits is a key opinion leader and research collaborator with IDEXX and Elanco Animal Health and research collaborator with Galaxy Diagnostics; Andrew Hanzlicek is an employee of MiraVista Diagnostics; Xavier Roura consults with Elanco, Idexx, Hill's, Purina, Affinity, Zoetis, Royal Canin, Merck Sharp and Dohme, Leti, Dechra, Bioiberica, Pharmacross, Nano1Health, Vetgenomics, Ecuphar, SantéVet, Fatro, Virbac, and Boehringer Ingelheim; Barbara Kohn has held lectures, had research

collaborations and acted as a consultant for veterinary pharmaceutical and diagnostic companies. No other authors declare a conflict of interest.

OFF-LABEL ANTIMICROBIAL DECLARATION

Authors declare no off-label use of antimicrobials.

INSTITUTIONAL ANIMAL CARE AND USE COMMITTEE (IACUC) OR OTHER APPROVAL DECLARATION

Authors declare no IACUC or other approval was needed.

HUMAN ETHICS APPROVAL DECLARATION

Authors declare human ethics approval was not needed for this study.

ORCID

Dana N. LeVine  <https://orcid.org/0000-0002-1089-5640>

Linda Kidd  <https://orcid.org/0000-0002-2464-0796>

Oliver A. Garden  <https://orcid.org/0000-0002-4133-9487>

Marjory B. Brooks  <https://orcid.org/0000-0001-5489-9013>

Robert Goggs  <https://orcid.org/0000-0001-7446-6987>

Andrew J. Mackin  <https://orcid.org/0000-0001-8465-0198>

Yu-Mei Chang  <https://orcid.org/0000-0001-6388-9626>

Barbara Glanemann  <https://orcid.org/0000-0003-4830-7610>

Maria C. Naskou  <https://orcid.org/0000-0001-9255-7794>

Lise N. Nielsen  <https://orcid.org/0000-0002-3988-0979>

Adam J. Birkenheuer  <https://orcid.org/0000-0002-2617-2252>

Andrew S. Hanzlicek  <https://orcid.org/0000-0001-6523-4033>

Kathrin F. Langner  <https://orcid.org/0000-0002-5058-7140>

Erin Lashnits  <https://orcid.org/0000-0003-0949-5698>

Katharine F. Lunn  <https://orcid.org/0000-0001-7083-5861>

Kelly M. Makielski  <https://orcid.org/0000-0001-7878-2370>

Eva Spada  <https://orcid.org/0000-0003-3898-6955>

REFERENCES

1. LeVine DN, Brooks MB. Immune thrombocytopenia (ITP): pathophysiology update and diagnostic dilemmas. *Vet Clin Pathol*. 2019; 48(Suppl 1):17-28.
2. Lewis DC, Meyers KM. Canine idiopathic thrombocytopenic purpura. *J Vet Intern Med*. 1996;10:207-218.
3. Putsche JC, Kohn B. Primary immune-mediated thrombocytopenia in 30 dogs (1997-2003). *J Am Anim Hosp Assoc*. 2008;44: 250-257.
4. Wondratschek C, Weingart C, Kohn B. Primary immune-mediated thrombocytopenia in cats. *J Am Anim Hosp Assoc*. 2010;46:12-19.
5. Bianco D, Armstrong PJ, Washabau RJ. Presumed primary immune-mediated thrombocytopenia in four cats. *J Feline Med Surg*. 2008;10: 495-500.
6. Portielje JE, Westendorp RG, Kluijn-Nelemans HC, et al. Morbidity and mortality in adults with idiopathic thrombocytopenic purpura. *Blood*. 2001;97:2549-2554.
7. Consolini R, Legitimo A, Caparello MC. The centenary of immune thrombocytopenia – part 1: revising nomenclature and pathogenesis. *Front Pediatr*. 2016;4:102.
8. Harrington WJ, Minnich V, Hollingsworth JW, et al. Demonstration of a thrombocytopenic factor in the blood of patients with thrombocytopenic purpura. *J Lab Clin Med*. 1951;38:1-10.

9. Tiemeyer KH, Kuter DJ, Cairo CW, Hollenhorst MA. New insights into the glycobiology of immune thrombocytopenia. *Curr Opin Hematol*. 2023;30:210-218.
10. Audia S, Mahevas M, Nivet M, et al. Immune thrombocytopenia: recent advances in pathogenesis and treatments. *Hemasphere*. 2021; 5:e574.
11. Peerschke EI, Andemariam B, Yin W, et al. Complement activation on platelets correlates with a decrease in circulating immature platelets in patients with immune thrombocytopenic purpura. *Br J Haematol*. 2010;148:638-645.
12. Zhang F, Chu X, Wang L, et al. Cell-mediated lysis of autologous platelets in chronic idiopathic thrombocytopenic purpura. *Eur J Haematol*. 2006;76:427-431.
13. Zufferey A, Kapur R, Semple JW. Pathogenesis and therapeutic mechanisms in immune thrombocytopenia (ITP). *J Clin Med*. 2017;6:16.
14. Olsson B, Andersson PO, Jernas M, et al. T-cell-mediated cytotoxicity toward platelets in chronic idiopathic thrombocytopenic purpura. *Nat Med*. 2003;9:1123-1124.
15. Zhao C, Li X, Zhang F, Wang L, Peng J, Hou M. Increased cytotoxic T-lymphocyte-mediated cytotoxicity predominant in patients with idiopathic thrombocytopenic purpura without platelet autoantibodies. *Haematologica*. 2008;93:1428-1430.
16. Aledort LM, Hayward CP, Chen MG, et al. Prospective screening of 205 patients with ITP, including diagnosis, serological markers, and the relationship between platelet counts, endogenous thrombopoietin, and circulating antithrombopoietin antibodies. *Am J Hematol*. 2004;76:205-213.
17. Chang M, Qian JX, Lee SM, et al. Tissue uptake of circulating thrombopoietin is increased in immune-mediated compared with irradiated thrombocytopenic mice. *Blood*. 1999;93:2515-2524.
18. Grozovsky R, Begonja AJ, Liu K, et al. The Ashwell-Morell receptor regulates hepatic thrombopoietin production via JAK2-STAT3 signaling. *Nat Med*. 2015;21:47-54.
19. Bachman DE, Forman MA, Hostutler RA, Corn S, Lin JM, Kociba GJ. Prospective diagnostic accuracy evaluation and clinical utilization of a modified assay for platelet-associated immunoglobulin in thrombocytopenic and nonthrombocytopenic dogs. *Vet Clin Pathol*. 2015;44: 355-368.
20. Scott MA, Kaiser L, Davis JM, Schwartz KA. Development of a sensitive immunoradiometric assay for detection of platelet surface-associated immunoglobulins in thrombocytopenic dogs. *Am J Vet Res*. 2002;63:124-129.
21. Dircks BH, Schuberth HJ, Mischke R. Underlying diseases and clinicopathologic variables of thrombocytopenic dogs with and without platelet-bound antibodies detected by use of a flow cytometric assay: 83 cases (2004-2006). *J Am Vet Med Assoc*. 2009;235:960-966.
22. Makielski KM, Brooks MB, Wang C, Cullen JN, O'Connor AM, LeVine DN. Development and implementation of a novel immune thrombocytopenia bleeding score for dogs. *J Vet Intern Med*. 2018; 32:1041-1050.
23. Garden OA, Kidd L, Mexas AM, et al. ACVIM consensus statement on the diagnosis of immune-mediated hemolytic anemia in dogs and cats. *J Vet Intern Med*. 2019;33:313-334.
24. Wasserkug-Naor A. Platelet kinetics and laboratory evaluation of thrombocytopenia. In: Brooks MB, Harr KE, Seelig DM, Wardrop KJ, Weiss DJ, eds. *Schalm's Veterinary Hematology*. 7th ed. Hoboken NJ, Wiley-Blackwell; 2022:675-685.
25. Flatland B, Baral RM, Freeman KP. Current and emerging concepts in biological and analytical variation applied in clinical practice. *J Vet Intern Med*. 2020;34:2691-2700.
26. Nabity MB, Harr KE, Camus MS, Flatland B, Vap LM. ASVCP guidelines: allowable total error hematology. *Vet Clin Pathol*. 2018;47:9-21.
27. Stokol T, Erb HN. A comparison of platelet parameters in EDTA- and citrate-anticoagulated blood in dogs. *Vet Clin Pathol*. 2007;36: 148-154.
28. Mylonakis ME, Leontides L, Farmaki R, Kostoulas P, Koutinas AF, Christopher M. Effect of anticoagulant and storage conditions on platelet size and clumping in healthy dogs. *J Vet Diagn Invest*. 2008; 20:774-779.
29. Norman EJ, Barron RC, Nash AS, et al. Prevalence of low automated platelet counts in cats: comparison with prevalence of thrombocytopenia based on blood smear estimation. *Vet Clin Pathol*. 2001;30: 137-140.
30. Baccini V, Genevieve F, Jacqmin H, et al. Platelet counting: ugly traps and good advice. Proposals from the French-Speaking Cellular Hematology Group (GFHC). *J Clin Med*. 2020;9:9.
31. Weiss DJ, Townsend E. Evaluation of reticulated platelets in dogs. *Comp Haematol Int*. 1998;88:166-170.
32. Zmigrodzka M, Guzera M, Winnicka A. Evaluation of reticulated platelets in dogs with breed-related thrombocytopenia. *Pol J Vet Sci*. 2014;17:137-142.
33. Pankraz A, Bauer N, Moritz A. Comparison of flow cytometry with the Sysmex XT2000iV automated analyzer for the detection of reticulated platelets in dogs. *Vet Clin Pathol*. 2009;38:30-38.
34. Hanahachi A, Kano R, Watari T, Hasegawa A. Thiazole orange-positive platelets in a dog with idiopathic thrombocytopenic purpura. *Vet Rec*. 2002;150:48-49.
35. Silva LF, Golim MA, Takahira RK. Measurement of thrombopoietic activity through the quantification of megakaryocytes in bone marrow cytology and reticulated platelets. *Res Vet Sci*. 2012;93: 313-317.
36. Dircks B, Schuberth HJ, Mischke R. Clinical and laboratory-diagnosed parameters in 21 dogs with primary immune-mediated thrombocytopenia. *Tierarztl Prax Ausg K Kleintiere Heimtiere*. 2011; 39:17-24.
37. Kohn B, Engelbrecht R, Leibold W, et al. Clinical findings, diagnostics and treatment results in primary and secondary immune-mediated thrombocytopenia in the dog. *Kleintierpraxis*. 2000;45: 893-907.
38. Schwartz D, Sharkey L, Armstrong PJ, Knudson C, Kelley J. Platelet volume and plateletcrit in dogs with presumed primary immune-mediated thrombocytopenia. *J Vet Intern Med*. 2014;28: 1575-1579.
39. Smith JR, Smith KF, Brainard BM. Platelet parameters from an automated hematology analyzer in dogs with inflammatory clinical diseases. *Vet J*. 2014;201:406-411.
40. Sullivan PS, Manning KL, McDonald TP. Association of mean platelet volume and bone marrow megakaryocytopoiesis in thrombocytopenic dogs: 60 cases (1984-1993). *J Am Vet Med Assoc*. 1995;206: 332-334.
41. Wilkerson MJ, Shuman W, Swist S, Harkin K, Meinkoth J, Kocan AA. Platelet size, platelet surface-associated IgG, and reticulated platelets in dogs with immune-mediated thrombocytopenia. *Vet Clin Pathol*. 2001;30:141-149.
42. Northern J, Tvedten HW. Diagnosis of microthrombocytosis and immune-mediated thrombocytopenia in dogs with thrombocytopenia: 68 cases (1987-1989). *J Am Vet Med Assoc*. 1992;200: 368-372.
43. Gelain ME, Bertazzolo W, Tutino G, Pogliani E, Cian F, Boudreaux MK. A novel point mutation in the beta1-tubulin gene in asymptomatic macrothrombocytopenic Norfolk and Cairn Terriers. *Vet Clin Pathol*. 2014;43:317-321.
44. Davis B, Toivio-Kinnucan M, Schuller S, Boudreaux MK. Mutation in beta1-tubulin correlates with macrothrombocytopenia in Cavalier King Charles Spaniels. *J Vet Intern Med*. 2008;22:540-545.
45. Michimoto T, Okamura T, Suzuki K, et al. Thiazole orange positive platelets in a dog with Evans' syndrome. *J Vet Med Sci*. 2004;66:1305-1306.
46. Shropshire S, Dow S, Lappin M. Detection and dynamics of anti-platelet antibodies in thrombocytopenic dogs with and without

- idiopathic immune thrombocytopenia. *J Vet Intern Med.* 2020;34:700-709.
47. Grindem CB, Breitschwerdt EB, Corbett WT, Jans HE. Epidemiologic survey of thrombocytopenia in dogs: a report on 987 cases. *Vet Clin Pathol.* 1991;20:38-43.
 48. Botsch V, Kuchenhoff H, Hartmann K, et al. Retrospective study of 871 dogs with thrombocytopenia. *Vet Rec.* 2009;164:647-651.
 49. Cockburn C, Troy GC. A retrospective study of sixty-two cases of thrombocytopenia in the dog. *Southwest Vet.* 1986;37:133-141.
 50. Ellis J, Bell R, Barnes DC, Miller R. Prevalence and disease associations in feline thrombocytopenia: a retrospective study of 194 cases. *J Small Anim Pract.* 2018;59:531-538.
 51. Jordan HL, Grindem CB, Breitschwerdt EB. Thrombocytopenia in cats: a retrospective study of 41 cases. *J Vet Intern Med.* 1993;7:261-265.
 52. Rodeghiero F, Stasi R, Gernsheimer T, et al. Standardization of terminology, definitions and outcome criteria in immune thrombocytopenic purpura of adults and children: report from an international working group. *Blood.* 2009;113:2386-2393.
 53. Stasi R, Amadori S, Osborn J, Newland AC, Provan D. Long-term outcome of otherwise healthy individuals with incidentally discovered borderline thrombocytopenia. *PLoS Med.* 2006;3:e24.
 54. O'Marra SK, Delaforcade AM, Shaw SP. Treatment and predictors of outcome in dogs with immune-mediated thrombocytopenia. *J Am Vet Med Assoc.* 2011;238:346-352.
 55. Rozanski EA, Callan MB, Hughes D, Sanders N, Giger U. Comparison of platelet count recovery with use of vincristine and prednisone or prednisone alone for treatment for severe immune-mediated thrombocytopenia in dogs. *J Am Vet Med Assoc.* 2002;220:477-481.
 56. Simpson K, Chapman P, Klag A. Long-term outcome of primary immune-mediated thrombocytopenia in dogs. *J Small Anim Pract.* 2018;59:674-680.
 57. Jans HE, Armstrong PJ, Price GS. Therapy of immune mediated thrombocytopenia. A retrospective study of 15 dogs. *J Vet Intern Med.* 1990;4:4-7.
 58. Williams DA, Maggio-Price L. Canine idiopathic thrombocytopenia: clinical observations and long-term follow-up in 54 cases. *J Am Vet Med Assoc.* 1984;185:660-663.
 59. Miller MD, Lunn KF. Diagnostic use of cytologic examination of bone marrow from dogs with thrombocytopenia: 58 cases (1994-2004). *J Am Vet Med Assoc.* 2007;231:1540-1544.
 60. Busse L, Mischke R. Megakaryopoiesis in bone marrow of dogs with autoimmune-induced thrombocytopenia and *Ehrlichia canis* infection. *Tierarztl Umsch.* 1998;53:703-708.
 61. Lachowicz JL, Post GS, Moroff SD, Mooney SC. Acquired amegakaryocytic thrombocytopenia—four cases and a literature review. *J Small Anim Pract.* 2004;45:507-514.
 62. Neunert C, Lim W, Crowther M, et al. The American Society of Hematology 2011 evidence-based practice guideline for immune thrombocytopenia. *Blood.* 2011;117:4190-4207.
 63. Cooper SA, Huang AA, Raskin RE, Weng HY, Scott-Moncrieff JC. Clinical data, clinicopathologic findings and outcome in dogs with amegakaryocytic thrombocytopenia and primary immune-mediated thrombocytopenia. *J Small Anim Pract.* 2016;57:142-147.
 64. Murtaugh RJ, Jacobs RM. Suspected immune-mediated megakaryocytic hypoplasia or aplasia in a dog. *J Am Vet Med Assoc.* 1985;186:1313-1315.
 65. Polydoros T, Ioannidi OM, Korsavvidis I, Stefanidis S, Antoniadis T, Mylonakis ME. Romiplostim as adjunctive treatment of refractory amegakaryocytic immune thrombocytopenia in a dog. *Top Companion Anim Med.* 2021;42:100488.
 66. Campbell KL, George JW, Greene CE. Application of the enzyme-linked immunosorbent assay for the detection of platelet antibodies in dogs. *Am J Vet Res.* 1984;45:2561-2564.
 67. Kristensen AT, Weiss DJ, Klausner JS, Laber J, Christie DJ. Detection of antiplatelet antibody with a platelet immunofluorescence assay. *J Vet Intern Med.* 1994;8:36-39.
 68. Lewis DC, McVey DS, Shuman WS, Muller WB. Development and characterization of a flow cytometric assay for detection of platelet-bound immunoglobulin G in dogs. *Am J Vet Res.* 1995;56:1555-1558.
 69. Lewis DC, Meyers KM. Studies of platelet-bound and serum platelet-bindable immunoglobulins in dogs with idiopathic thrombocytopenic purpura. *Exp Hematol.* 1996;24:696-701.
 70. Shropshire S, Dow S, Lappin M. Validation of a clinically applicable flow cytometric assay for the detection of immunoglobulin associated platelets in dogs. *Vet Immunol Immunopathol.* 2018;202:109-114.
 71. Brooks MB, Maruyama H, Cremer SE, et al. Preliminary evaluation of a flow cytometric assay with microsphere controls for the detection of platelet-bound antibodies in canine immune thrombocytopenia. *Vet Clin Pathol.* 2022;51:330-338.
 72. Joshi BC, Jain NC. Detection of antiplatelet antibody in serum and on megakaryocytes of dogs with autoimmune thrombocytopenia. *Am J Vet Res.* 1976;37:681-685.
 73. Kristensen AT, Weiss DJ, Klausner JS, Laber J, Christie DJ. Comparison of microscopic and flow cytometric detection of platelet antibody in dogs suspected of having immune-mediated thrombocytopenia. *Am J Vet Res.* 1994;55:1111-1114.
 74. Lewis DC, Meyers KM, Callan MB, Bücheler J, Giger U. Detection of platelet-bound and serum platelet-bindable antibodies for diagnosis of idiopathic thrombocytopenic purpura in dogs. *J Am Vet Med Assoc.* 1995;206:47-52.
 75. McVey DS, Shuman WS. Detection of antiplatelet immunoglobulin in thrombocytopenic dogs. *Vet Immunol Immunopathol.* 1989;22:101-111.
 76. Zenker I, Keller L, Meichner K, Unterer S, Hartmann K. Immune mediated destruction of platelets in dogs with heat stroke: a prospective study. *Tierarztl Prax Ausg K Kleintiere Heimtiere.* 2009;37:314-318.
 77. Wilkins RJ, Hurvitz AI, Dodds-Laffin WJ. Immunologically mediated thrombocytopenia in the dog. *J Am Vet Med Assoc.* 1973;163:277-282.
 78. Helfand SC. Neoplasia and immune-mediated thrombocytopenia. *Vet Clin North Am Small Anim Pract.* 1988;18:267-270.
 79. Kristensen AT, Weiss DJ, Klausner JS. Platelet dysfunction associated with immune-mediated thrombocytopenia in dogs. *J Vet Intern Med.* 1994;8:323-327.
 80. Lewis DC, Bruyette DS, Kellerman DL, Smith SA. Thrombocytopenia in dogs with anticoagulant rodenticide-induced hemorrhage: eight cases (1990-1995). *J Am Anim Hosp Assoc.* 1997;33:417-422.
 81. Estrin MA, Wehausen CE, Jessen CR, et al. Disseminated intravascular coagulation in cats. *J Vet Intern Med.* 2006;20:1334-1339.
 82. Öberg J, Tvedten H. Thromboelastography in a cat with steroid responsive thrombocytopenia. *Comp Clin Pathol.* 2010;19:429-431.
 83. Peterson JL, Couto CG, Wellman ML. Hemostatic disorders in cats: a retrospective study and review of the literature. *J Vet Intern Med.* 1995;9:298-303.
 84. Thomas JS, Green RA. Clotting times and antithrombin III activity in cats with naturally developing diseases: 85 cases (1984-1994). *J Am Vet Med Assoc.* 1998;213:1290-1295.
 85. Davidow EB, Brainard B, Martin LG, et al. Use of fresh platelet concentrate or lyophilized platelets in thrombocytopenic dogs with clinical signs of hemorrhage: a preliminary trial in 37 dogs. *J Vet Emerg Crit Care (San Antonio).* 2012;22:116-125.
 86. Martinez C, Mooney CT, Shiel RE, Tang PK, Mooney L, O'Neill EJ. Evaluation of red blood cell distribution width in dogs with various illnesses. *Can Vet J.* 2019;60:964-971.

87. Orcutt ES, Lee JA, Bianco D. Immune-mediated hemolytic anemia and severe thrombocytopenia in dogs: 12 cases (2001-2008). *J Vet Emerg Crit Care (San Antonio)*. 2010;20:338-345.
88. Antognoni MT, Veronesi F, Morganti G, Mangili V, Fruganti G, Miglio A. Natural infection of *Anaplasma platys* in dogs from Umbria region (Central Italy). *Vet Ital*. 2014;50:49-56.
89. Atkinson M. IMT in spaniel after vaccination. *Vet Times*. 2011;41:10-11.
90. Bexfield NH, Villiers EJ, Herrtage ME. Immune-mediated haemolytic anaemia and thrombocytopenia associated with *Anaplasma phagocytophilum* in a dog. *J Small Anim Pract*. 2005;46:543-548.
91. Bloom JC, Blackmer SA, Bugelski PJ, Sowinski JM, Saunders LZ. Gold-induced immune thrombocytopenia in the dog. *Vet Pathol*. 1985;22:492-499.
92. Cain GR, Cain JL, Turrel JM, Theilen G, Jain NC. Immune-mediated hemolytic anemia and thrombocytopenia in a cat after bone marrow transplantation. *Vet Pathol*. 1988;25:161-162.
93. Chethan GE, Thakur N, Madhesh E, et al. Therapeutic management of *Ehrlichia canis* induced pancytopenia and hepatopathy in a dog. *J Vet Parasitol*. 2016;30:28-31.
94. Chirek A, Silaghi C, Pfister K, Kohn B. Granulocytic anaplasmosis in 63 dogs: clinical signs, laboratory results, therapy and course of disease. *J Small Anim Pract*. 2018;59:112-120.
95. Codner EC, Roberts RE, Ainsworth AG. Atypical findings in 16 cases of canine ehrlichiosis. *J Am Vet Med Assoc*. 1985;186:166-169.
96. Cortese L, Sica M, Piantedosi D, et al. Secondary immune-mediated thrombocytopenia in dogs naturally infected by *Leishmania infantum*. *Vet Rec*. 2009;164:778-782.
97. Cortese L, Terrazzano G, Piantedosi D, et al. Prevalence of anti-platelet antibodies in dogs naturally co-infected by *Leishmania infantum* and *Ehrlichia canis*. *Vet J*. 2011;188:118-121.
98. Davis WM. Hapten-induced, immune-mediated thrombocytopenia in a dog. *J Am Vet Med Assoc*. 1984;184:976-977.
99. Franca RT, Pillat MM, da Silva CB, et al. Surface immunoglobulins of erythrocytes and platelets in dogs naturally infected by *Rangelia vitalii*. *Microb Pathog*. 2018;121:245-251.
100. Gaunt S, Beall M, Stillman B, et al. Experimental infection and co-infection of dogs with *Anaplasma platys* and *Ehrlichia canis*: hematologic, serologic and molecular findings. *Parasites Vectors*. 2010;3:33.
101. Goddard A, Leisewitz AL, Kristensen AT, Schoeman JP. Platelet activation and platelet-leukocyte interaction in dogs naturally infected with *Babesia rossi*. *Vet J*. 2015;205:387-392.
102. Gould SM, McInnes EL. Immune-mediated thrombocytopenia associated with *Angiostrongylus vasorum* infection in a dog. *J Small Anim Pract*. 1999;40:227-232.
103. Harrus S, Waner T, Weiss DJ, Keysary A, Bark H. Kinetics of serum antiplatelet antibodies in experimental acute canine ehrlichiosis. *Vet Immunol Immunopathol*. 1996;51:13-20.
104. Harrus S, Waner T, Keysary A, Aroch I, Voet H, Bark H. Investigation of splenic functions in canine monocytic ehrlichiosis. *Vet Immunol Immunopathol*. 1998;62:15-27.
105. Helfand SC, Couto CG, Madewell BR. Immune-mediated thrombocytopenia associated with solid tumors in dogs. *J Am Anim Hosp Assoc*. 1985;21:787-794.
106. Jo'Neill E, Acke E, Tobin E, et al. Immune-mediated thrombocytopenia associated with *angiostrongylus vasorum* infection in a Jack Russell terrier. *Ir Vet J*. 2010;63:434-440.
107. Kohn B, Engelbrecht R, Leibold W, et al. Klinische befunde, diagnostik und behandlungsdrfolge bei der primaren und sekundaren immunbedingten Thrombozytopenie beim Hund. *Kleintierpraxis*. 2000;45:889-956.
108. Kopecny L, Palm CA, Naylor S, Kirby J, Cowgill LD. Application of therapeutic plasma exchange in dogs with immune-mediated thrombocytopenia. *J Vet Intern Med*. 2020;34:1576-1581.
109. Mathe A, Voros K, Papp L, et al. Clinical manifestations of canine babesiosis in Hungary (63 cases). *Acta Vet Hung*. 2006;54:367-385.
110. Nakamura RK, Fenty RK, Bianco D. Presumptive immune-mediated thrombocytopenia secondary to massive Africanized bee envenomation in a dog. *J Vet Emerg Crit Care (San Antonio)*. 2013;23:652-656.
111. Oines O, Storli K, Brun-Hansen H. First case of babesiosis caused by *Babesia canis canis* in a dog from Norway. *Vet Parasitol*. 2010;171:350-353.
112. Paim CB, Paim FC, da Silva AS, et al. Thrombocytopenia and platelet activity in dogs experimentally infected with *Rangelia vitalii*. *Vet Parasitol*. 2012;185:131-137.
113. Peterson ME, Kintzer PP, Hurvitz AI. Methimazole treatment of 262 cats with hyperthyroidism. *J Vet Intern Med*. 1988;2:150-157.
114. Pierce KR, Marrs GE, Hightower D. Acute canine ehrlichiosis: platelet survival and factor 3 assay. *Am J Vet Res*. 1977;38:1821-1825.
115. Raguvaran R, Mondal RSK, Mondal DB. Management of immune mediated hemolytic anemia (IMHA) secondary to paracetamol toxicity in a dog. *Intas Polivet*. 2019;20:180-181.
116. Sangeetha SG, Ajith Y, Dixit SK, et al. PCR based diagnosis and clinical management of ehrlichiosis in a dog. *Intas Polivet*. 2017;18:187-191.
117. Sato M, Veir JK, Shropshire SB, Lappin MR. *Ehrlichia canis* in dogs experimentally infected, treated, and then immune suppressed during the acute or subclinical phases. *J Vet Intern Med*. 2020;34:1214-1221.
118. Senturk S, Temizel M. Treatment of immune-mediated hemolytic anemia and thrombocytopenia with vincristine in a dog. *J Fac Vet Med*. 2001;20:85-91.
119. Singh PT, Panagawkar GR. Haemostatic disorders in dogs infected with transmissible venereal tumour. *Indian Vet J*. 1998;75:879-881.
120. Sullivan PS, Arrington K, West R, et al. Thrombocytopenia associated with administration of trimethoprim/sulfadiazine in a dog. *J Am Vet Med Assoc*. 1992;201:1741-1744.
121. Terrazzano G, Cortese L, Piantedosi D, et al. Presence of anti-platelet IgM and IgG antibodies in dogs naturally infected by *Leishmania infantum*. *Vet Immunol Immunopathol*. 2006;110:331-337.
122. Vasilopoulos RJ, Mackin A, Laverne SN, Trepanier LA. Nephrotic syndrome associated with administration of sulfadimethoxine/ormetoprim in a doberman. *J Small Anim Pract*. 2005;46:232-236.
123. Waner T, Leykin I, Shinitsky M, et al. Detection of platelet-bound antibodies in beagle dogs after artificial infection with *Ehrlichia canis*. *Vet Immunol Immunopathol*. 2000;77:145-150.
124. Waner T, Lurie S. Aspirin implicated immune-mediated haemolytic anaemia and thrombocytopenia in a dog—a case report. *Refuah Vet*. 1992;47:112-115.
125. Weiss B. Selective dysmegakaryopoiesis in thrombocytopenic dogs (1996-2002). *Comp Clin Path*. 2004;13:24-28.
126. Axthelm MK, Krakowka S. Canine distemper virus-induced thrombocytopenia. *Am J Vet Res*. 1987;48:1269-1275.
127. Ridgway J, Jergens AE, Niyo Y. Possible causal association of idiopathic inflammatory bowel disease with thrombocytopenia in the dog. *J Am Anim Hosp Assoc*. 2001;37:65-74.
128. Bloom JC, Thiem PA, Sellers TS, Lewis HB, Deldar A. Cephalosporin-induced immune cytopenia in the dog: demonstration of erythrocyte-, neutrophil-, and platelet-associated IgG following treatment with cefazedone. *Am J Hematol*. 1988;28:71-78.
129. Frydman GH, Davis N, Beck PL, Fox JG. *Helicobacter pylori* eradication in patients with immune thrombocytopenic purpura: a review and the role of biogeography. *Helicobacter*. 2015;20:239-251.
130. Alhomoud M, Alhobayb T, Armitage K. COVID-19 infection triggering thrombotic thrombocytopenic purpura. *IDCases*. 2021;26:e01256.
131. Santhosh S, Malik B, Kalantary A, Kunadi A. Immune thrombocytopenic purpura (ITP) following natural COVID-19 infection. *Cureus*. 2022;14:e26582.
132. Kuwana M. *Helicobacter pylori*-associated immune thrombocytopenia: clinical features and pathogenic mechanisms. *World J Gastroenterol*. 2014;20:714-723.
133. Takahashi T, Yujiri T, Shinohara K, et al. Molecular mimicry by *Helicobacter pylori* CagA protein may be involved in the pathogenesis of

- H. pylori*-associated chronic idiopathic thrombocytopenic purpura. *Br J Haematol.* 2004;124:91-96.
134. Satoh T, Uojima H, Wada N, et al. Introduction of direct-acting antiviral agents alters frequencies of anti-GPIIb/IIIa antibody-producing B cells in chronic hepatitis C patients with thrombocytopenia. *Platelets.* 2023;34:2161498.
 135. Kelton JG, Keystone J, Moore J, et al. Immune-mediated thrombocytopenia of malaria. *J Clin Invest.* 1983;71:832-836.
 136. Cines DB, Liebman H, Stasi R. Pathobiology of secondary immune thrombocytopenia. *Semin Hematol.* 2009;46:S2-S14.
 137. Franchini M, Veneri D, Lippi G. Thrombocytopenia and infections. *Expert Rev Hematol.* 2017;10:99-106.
 138. Swinkels M, Rijkers M, Voorberg J, Vidarsson G, Leebeek FWG, Jansen AJG. Emerging concepts in immune thrombocytopenia. *Front Immunol.* 2018;9:880.
 139. Collicutt NB, Garner B. Erythrocyte dysplasia in peripheral blood smears from 5 thrombocytopenic dogs treated with vincristine sulfate. *Vet Clin Pathol.* 2013;42:458-464.
 140. Grindem CB, Breitschwerdt EB, Perkins PC, Cullins LD, Thomas TJ, Hegarty BC. Platelet-associated immunoglobulin (antiplatelet antibody) in canine Rocky Mountain spotted fever and ehrlichiosis. *J Am Anim Hosp Assoc.* 1999;35:56-61.
 141. Harrus S, Day MJ, Waner T, Bark H. Presence of immune-complexes, and absence of antinuclear antibodies, in sera of dogs naturally and experimentally infected with *Ehrlichia canis*. *Vet Microbiol.* 2001;83:343-349.
 142. Kohn B, Bal G, Chirek A, Rehbein S, Salama A. Treatment of 5 dogs with immune-mediated thrombocytopenia using Romiplostim. *BMC Vet Res.* 2016;12:96.
 143. Moraes LF, Takahira RK, Golim M, et al. Avaliacao das alteracoes hemostaticas e do risco tromboembolico em caes com AHIM. *Pesq Vet Bras.* 2016;36:405-411.
 144. Nair AD, Cheng C, Ganta CK, et al. Comparative experimental infection study in dogs with *Ehrlichia canis*, *E. chaffeensis*, *Anaplasma platys* and *A. phagocytophilum*. *PLoS One.* 2016;11:e0148239.
 145. Neelawala D, Dissanayake DRA, Prasada DVP, Silva ID. Analysis of risk factors associated with recurrence of canine babesiosis caused by *Babesia gibsoni*. *Comp Immunol Microbiol Infect Dis.* 2021;74:101572.
 146. Ploneczka-Janeczko K, Rypula K. Application of a flow cytometry in differentiation of antibodies accompanying platelets in *Ehrlichia canis* and *Borrelia burgdorferi* infections in dogs. *Cent Eur J Immunol.* 2011;36:174-179.
 147. Quorllo BA, Buch J, Chandrashekar R, et al. Clinicopathological findings in 41 dogs (2008-2018) naturally infected with *Ehrlichia ewingii*. *J Vet Intern Med.* 2019;33:618-629.
 148. Tami J, Martinez I, Tami M, et al. Identification of *Ehrlichia* species in blood smear. *Infect Dis Clin Pract.* 1996;5:555-557.
 149. Birkenheuer AJ, Buch J, Beall MJ, Braff J, Chandrashekar R. Global distribution of canine *Babesia* species identified by a commercial diagnostic laboratory. *Vet Parasitol Reg Stud Rep.* 2020;22:100471.
 150. Reardon MJ, Pierce KR. Acute experimental canine ehrlichiosis. I. Sequential reaction of the hemic and lymphoreticular systems. *Vet Pathol.* 1981;18:48-61.
 151. Reardon MJ, Pierce KR. Acute experimental canine ehrlichiosis. II. Sequential reaction of the hemic and lymphoreticular system of selectively immunosuppressed dogs. *Vet Pathol.* 1981;18:384-395.
 152. Mylonakis ME, Day MJ, Siarkou V, Vernau W, Koutinas AF. Absence of myelofibrosis in dogs with myelosuppression induced by *Ehrlichia canis* infection. *J Comp Pathol.* 2010;142:328-331.
 153. Greisen A. Leishmania as a cause of Evans syndrome in a Greek street dog. *Dansk Veterinaertidsskrift.* 2008;91:8-11.
 154. Koutinas AF, Koutinas CK. Pathologic mechanisms underlying the clinical findings in canine leishmaniasis due to *Leishmania infantum/chagasi*. *Vet Pathol.* 2014;51:527-538.
 155. Rani GF, Preham O, Ashwin H, Brown N, Hitchcock IS, Kaye PM. Dissecting pathways to thrombocytopenia in a mouse model of visceral leishmaniasis. *Blood Adv.* 2021;5:1627-1637.
 156. Kohn B, Galke D, Beelitz P, Pfister K. Clinical features of canine granulocytic anaplasmosis in 18 naturally infected dogs. *J Vet Intern Med.* 2008;22:1289-1295.
 157. Mazepa AW, Kidd LB, Young KM, Trepanier LA. Clinical presentation of 26 anaplasma phagocytophilum-seropositive dogs residing in an endemic area. *J Am Anim Hosp Assoc.* 2010;46:405-412.
 158. Inokuma H, Okuda M, Yoshizaki Y, et al. Clinical observations of *Babesia gibsoni* infection with low parasitaemia confirmed by PCR in dogs. *Vet Rec.* 2005;156:116-118.
 159. Birkenheuer AJ, Correa MT, Levy MG, Breitschwerdt EB. Geographic distribution of babesiosis among dogs in the United States and association with dog bites: 150 cases (2000-2003). *J Am Vet Med Assoc.* 2005;227:942-947.
 160. Gonde S, Chhabra S, Lingla LD, et al. Clinico-haemato-biochemical changes in naturally occurring canine babesiosis in Punjab, India. *Malaysian J Vet Res.* 2017;8:37-44.
 161. Tuttle AD, Birkenheuer AJ, Juopperi T, Levy MG, Breitschwerdt EB. Concurrent bartonellosis and babesiosis in a dog with persistent thrombocytopenia. *J Am Vet Med Assoc.* 2003;223:1280-1301.
 162. Vijayalakshmi P, Srinivasan SR, Vairamuthu S, et al. Clinico pathological features in dogs associated with *Babesiosis*. *Indian Vet J.* 2014;91:21-24.
 163. Zygnier W, Gojska-Zygnier O, Szmidt K. Vincristine and cyclophosphamide in the treatment of persistent anemia and thrombocytopenia related to *Babesia canis* infection in a dog. *Zycie Wet.* 2011;86:374-378.
 164. Schoeman T, Lobetti RG, Jacobson LS, Penzhorn BL. Feline babesiosis: signalment, clinical pathology and concurrent infections. *J S Afr Vet Assoc.* 2001;72:4-11.
 165. Birkenheuer AJ, Neel J, Ruslander D, Levy MG, Breitschwerdt EB. Detection and molecular characterization of a novel large *Babesia* species in a dog. *Vet Parasitol.* 2004;124:151-160.
 166. Sikorski LE, Birkenheuer AJ, Holowaychuk MK, McCleary-Wheeler AL, Davis JM, Littman MP. Babesiosis caused by a large *Babesia* species in 7 immunocompromised dogs. *J Vet Intern Med.* 2010;24:127-131.
 167. Barash NR, Thomas B, Birkenheuer AJ, Breitschwerdt EB, Lemler E, Quorllo BA. Prevalence of *Babesia* spp. and clinical characteristics of *Babesia vulpes* infections in north American dogs. *J Vet Intern Med.* 2019;33:2075-2081.
 168. Birkenheuer AJ, Levy MG, Savary KC, Gager RB, Breitschwerdt EB. *Babesia gibsoni* infections in dogs from North Carolina. *J Am Anim Hosp Assoc.* 1999;35:125-128.
 169. Vayne C, Guery EA, Rollin J, et al. Pathophysiology and diagnosis of drug-induced immune thrombocytopenia. *J Clin Med.* 2020;9:9.
 170. Bakchoul T, Marini I. Drug-associated thrombocytopenia. *Hematology Am Soc Hematol Educ Program.* 2018;2018:576-583.
 171. Xie W, Hu N, Cao L. Immune thrombocytopenia induced by immune checkpoint inhibitors in lung cancer: case report and literature review. *Front Immunol.* 2021;12:790051.
 172. Lerner W, Caruso R, Faig D, Karparkin S. Drug-dependent and non-drug-dependent antiplatelet antibody in drug-induced immunologic thrombocytopenic purpura. *Blood.* 1985;66:306-311.
 173. Cain GR, Champlin R, Jain N. Immune thrombocytopenia in dogs after fetal liver hematopoietic cell transplantation. *Exp Hematol.* 1989;17:287-291.
 174. Fathi E, Jamshidi S. Case report: follow-up, diagnosis, clinical evidence, laboratory evaluation, and treatment of idiopathic

- thrombocytopenia using human intravenous immunoglobulin in a terrier dog. *Iran J Vet Sci Technol.* 2014;6:64-70.
175. Feldman BF. Demographics of canine immune-mediated haemolytic anaemia in the southeastern United States. *Comp Haematol Int.* 1996;6:42-45.
 176. Goggs R, Boag AK, Chan DL. Concurrent immune-mediated haemolytic anaemia and severe thrombocytopenia in 21 dogs. *Vet Rec.* 2008;163:323-327.
 177. Jackson ML, Kruth SA. Immune-mediated hemolytic anemia and thrombocytopenia in the dog: a retrospective study of 55 cases diagnosed from 1979 through 1983 at the Western College of Veterinary Medicine. *Can Vet J.* 1985;26:245-250.
 178. Larkin HA, Collins JD, Lambert NH. A fatal case of idiopathic thrombocytopenic purpura in a dog. *Ir Vet J.* 1972;26:25-28.
 179. Lavergne SN, Trepanier LA. Anti-platelet antibodies in a natural animal model of sulphonamide-associated thrombocytopenia. *Platelets.* 2007;18:595-604.
 180. Mellor PJ, Roulois AJ, Day MJ, et al. Neutrophilic dermatitis and immune-mediated haematological disorders in a dog: suspected adverse reaction to carprofen. *J Small Anim Pract.* 2005;46:237-242.
 181. Scott TN, Bailin HG, Jutkowitz LA, Scott MA, Lucidi CA. Bone marrow, blood, and clinical findings in dogs treated with phenobarbital. *Vet Clin Pathol.* 2021;50:122-131.
 182. Trepanier LA, Danhof R, Toll J, Watrous D. Clinical findings in 40 dogs with hypersensitivity associated with administration of potentiated sulfonamides. *J Vet Intern Med.* 2003;17:647-652.
 183. Vargo CL, Taylor SM, Haines DM. Immune mediated neutropenia and thrombocytopenia in 3 giant schnauzers. *Can Vet J.* 2007;48:1159-1163.
 184. Woods JP, Johnstone IB, Bienzie D, Balson G, Gartley CJ. Concurrent lymphangioma, immune-mediated thrombocytopenia, and von Willebrand's disease in a dog. *J Am Anim Hosp Assoc.* 1995;31:70-76.
 185. Kidd L, Maggi R, Diniz PP, et al. Evaluation of conventional and real-time PCR assays for detection and differentiation of spotted fever group rickettsia in dog blood. *Vet Microbiol.* 2008;129:294-303.
 186. Kidd L, Qurollo B, Lappin M, et al. Prevalence of vector-borne pathogens in Southern California dogs with clinical and laboratory abnormalities consistent with immune-mediated disease. *J Vet Intern Med.* 2017;31:1081-1090.
 187. Maggi RG, Birkenheuer AJ, Hegarty BC, Bradley JM, Levy MG, Breitschwerdt EB. Comparison of serological and molecular panels for diagnosis of vector-borne diseases in dogs. *Parasit Vectors.* 2014;7:127.
 188. Starkey LA, Barrett AW, Beall MJ, et al. Persistent *Ehrlichia ewingii* infection in dogs after natural tick infestation. *J Vet Intern Med.* 2015;29:552-555.
 189. Starkey LA, Barrett AW, Chandrashekar R, et al. Development of antibodies to and PCR detection of *Ehrlichia* spp. in dogs following natural tick exposure. *Vet Microbiol.* 2014;173:379-384.
 190. Riswari SF, Tunjungputri RN, Kullaya V, et al. Desialylation of platelets induced by Von Willebrand factor is a novel mechanism of platelet clearance in dengue. *PLoS Pathog.* 2019;15:e1007500.
 191. Jornet-Rius O, Mesalles-Naranjo M, Pastor J. Performance of the Sysmex XN-V hematology analyzer in determining the immature platelet fraction in dogs: a preliminary study and reference values. *Vet Clin Pathol.* 2023;52:433-442.
 192. Li J, van der Wal DE, Zhu G, et al. Desialylation is a mechanism of Fc-independent platelet clearance and a therapeutic target in immune thrombocytopenia. *Nat Commun.* 2015;6:7737.

SUPPORTING INFORMATION

Additional supporting information can be found online in the Supporting Information section at the end of this article.

How to cite this article: LeVine DN, Kidd L, Garden OA, et al. ACVIM consensus statement on the diagnosis of immune thrombocytopenia in dogs and cats. *J Vet Intern Med.* 2024; 38(4):1958-1981. doi:[10.1111/jvim.16996](https://doi.org/10.1111/jvim.16996)