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Quality of reporting of clinical trials in dogs and cats: An update

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Abstract

Background: Comprehensive reporting of clinical trials is essential to allow the trial reader to evaluate the methodological rigor of the trial and interpret the results. Since publication of the updated Consolidated Standards of Reporting Trials (CONSORT) guidelines for reporting of parallel clinical trials in humans, extensions for reporting of abstracts and crossover trials have been published.

Objectives: To describe the types of trials using dogs and cats published from 2015 to 2020 and to evaluate the quality of reporting of a sample of recently published parallel and crossover trials.

Animals: None.

Methods: A comprehensive search was conducted to identify parallel or crossover design clinical trials using dogs and cats published from January 1, 2015 onwards. Quality of reporting was evaluated on a subset of trials published during 2019. The reporting of items recommended in the CONSORT reporting guidelines for abstracts, parallel trials, and crossover trials was evaluated independently by 2 reviewers using standardized forms created for this study. Disagreements among reviewers were resolved by consensus. Results were tabulated descriptively.

Results: The frequency of reporting of trial features varied from low to high. There remain deficiencies in the quality of reporting of key methodological features and information needed to evaluate and interpret trial results.

Conclusions and Clinical Importance: There is still a need for authors, peer-reviewers, and editors to follow reporting guidelines such as CONSORT to maximize the value of clinical trials and to increase confidence in the validity of the trial results.

KEYWORDS
companion animals, CONSORT statement, trial reporting

1 | INTRODUCTION

Well-conducted randomized controlled trials provide the highest level of evidence for evaluating the efficacy of a treatment, when it is

Abbreviation: CONSORT, Consolidated Standards of Reporting Trials.

ethical and feasible to allocate study subjects to treatment groups. The ability of the reader of a trial to evaluate the methodological rigor with which the trial was conducted, as well as to interpret the trial results, is dependent on the trial authors clearly and accurately reporting the methods and the results of the trial. To address issues related to deficiencies in reporting in human health trials, the Consolidated Standards of Reporting Trials (CONSORT) statement, developed by expert consensus, was published in 2001 to provide guidance on reporting of parallel trials. The CONSORT statement comprises 22 items that should be reported in all trial reports. The CONSORT document consists of a publication describing the process of developing the guidelines[1] and a longer explanation and elaboration document.[2] A systematic review evaluating the impact of the CONSORT statement was published in 2012.[3] The authors of this review reported that journal endorsement of the CONSORT statement appeared to benefit the completeness of reporting of the trials that they published.

Although developed for human trials, the CONSORT guidelines might be applied to clinical trials in animals. An evaluation of reporting of clinical trials in dogs and cats using the CONSORT statement items identified substantive deficiencies in reporting of important features.[4] More recently, trial methodology and reporting were evaluated in 163 trials in tumor-bearing dogs.[5] The authors of this study also noted concerning deficiencies in reporting, including the observation that over 70% of trials did not identify the primary outcome. Blinding was comprehensively reported in only one-third of 195 randomized trials published between 2004 and 2010.[6] Thus, there is a clear need to improve reporting of clinical trials using dogs and cats. Indeed, the *Journal of Veterinary Internal Medicine* explicitly states that the CONSORT reporting guidelines should be followed.[7]

In the past decade, there have been several new developments related to reporting of clinical trials which are applicable to small animal trials. An updated version of the CONSORT statement was published in 2010,[8,9] and extensions to the CONSORT statement have been published for reporting of abstracts[10] and for reporting of crossover trials.[11] Given these developments in trial reporting, and the evidence of ongoing issues of inadequate reporting, there is a need to re-evaluate the reporting of clinical trials in dogs and cats to identify areas where improvements in reporting are warranted.

Therefore, the objectives of this study were:

1. To describe the types of clinical trials using dogs and cats published from 2015 to 2020.
2. To evaluate the quality of reporting of a sample of recently published parallel and crossover trials in dogs and cats.

2 | METHODS

The following definitions were used throughout this study:

- A clinical trial was defined as a controlled experiment conducted in live animals to prevent or treat a naturally occurring disease or condition, in which the interventions were intended for use in dogs or cats.
- A parallel trial was defined as a clinical trial in which the study units were allocation to 2 or more intervention groups with each study unit allocated to a single intervention group.
- A crossover trial was defined as a clinical trial in which each study unit serves as its own control by being assigned to each of the intervention groups at different time periods.

2.1 | Eligibility

Trials eligible for inclusion to address objective 1 were controlled trials with 2 or more concurrent intervention groups, using a parallel or crossover trial design, conducted in live dogs, cats, or both where dogs or cats were the target species (ie, not evaluated solely as a model for a human intervention or disease condition) and published in English from 2015 and 2020. Before-and-after trials, trials with deliberate exposure to the pathogen of interest or deliberate disease induction and trial protocols were not eligible. Trials meeting these eligibility criteria, published in 2019, and not solely evaluating pharmacokinetics, bioavailability, or safety were used to address objective 2. Restricting objective 2 to trials published in 2019, and to trials that did not solely evaluate pharmacokinetics, bioavailability, or safety, was based on feasibility of evaluating the anticipated number of trials within available resources. No sample size calculations were conducted as the study was not designed to allow statistical comparisons with the results of previous studies of reporting quality.

2.2 | Search for relevant trials

Searches to identify eligible trials were conducted on May 5, 2020 in MEDLINE (via PubMed) and CAB Direct (via the University of Guelph Library interface). The search was restricted to publications from 2015 to the date of the search. No language or study design filters were applied at the search stage.

The search terms were structured around species (cat or dog), study design (trials), and interventions. The searches were limited to search terms used in the title or abstract to restrict the results to a manageable number of citations. The full search string, as applied in MEDLINE via PubMed, is shown in Table 1.

2.3 | Selection of eligible trials

Four individuals were involved in selection of eligible trials (J. M. Sargeant, M. Plishka, S. C. Totton, E. R. Vriezen). Each article was assessed for eligibility by 2 of these individuals working independently, based on information provided in the title or abstract, with any disagreements resolved by consensus. An eligibility screening form was created in DistillerSR (Evidence Partners Inc., Ottawa, Ontario) and included the following questions:

TABLE 1 Search string applied to MEDLINE to identify clinical trials in cats or dogs published after 2015

Population terms:
("dogs"[MeSH Terms] OR "dogs"[All Fields]) OR "dog"[All Fields]) OR ("dogs"[MeSH Terms] OR "dogs"[All Fields])) OR ((((("canine s"[All Fields] OR "dogs"[MeSH Terms]) OR "dogs"[All Fields]) OR "canine"[All Fields]) OR "canines"[All Fields])) OR "cat"[All Fields]) OR ("cats"[MeSH Terms] OR "cats"[All Fields])) OR (((((("cats"[MeSH Terms] OR "cats"[All Fields]) OR "felines"[All Fields]) OR "felidae"[MeSH Terms]) OR "felidae"[All Fields]) OR "feline"[All Fields])
Linked to trial terms using "AND"
("clinical trials as topic"[MeSH Terms] OR (("clinical"[All Fields] AND "trials"[All Fields]) AND "topic"[All Fields])) OR "clinical trials as topic"[All Fields]) OR "trial"[All Fields]) OR "trial s"[All Fields]) OR "trialed"[All Fields]) OR "trialing"[All Fields]) OR "trials"[All Fields]) OR "RCT"[All Fields]) OR "random*"[All Fields])
Linked to intervention terms using "AND"
("drug*"[Title/Abstract] OR "surg*"[Title/Abstract]) OR "vacc*"[Title/Abstract]) OR "antibiotic*"[Title/Abstract]) OR "antimicrob*"[Title/Abstract]) OR "intervention"[Title/Abstract]) OR "treatment"[Title/Abstract])
Linked to publication data restriction using "AND"
January 1, 2015:3000/12/31[Date—Publication]

Note: For clarity of presentation, population, trial, outcome, and publication date terms are separated in this table.

1. Does the title or abstract describe a study in dogs and or cats (not including animal models of human interventions or illnesses)?
2. Does the title or abstract describe a controlled trial in live animals (at least 2 groups and investigator allocation to group) with natural exposure to the outcome (the disease or condition of interest was not deliberately induced by the investigator)?
3. Is the publication available in English?

If both reviewers agreed that the answer to any 1 of the above questions was "no," the citation was excluded from further consideration. The first 200 citations were evaluated by all individuals involved in conducting eligibility screening to ensure clarify of questions and for training purposes.

2.4 | Data collection

For all references passing eligibility screening, data were collected for descriptive purposes on the year of publication, species, and trial type based on an evaluation of the information provided in the citation information, title, or abstract (Table 2). Data collected were undertaken by the same 4 individuals who performed trial selection. Two reviewers working independently extracted this information from each trial using a structured form created in DistillerSR, with any disagreements resolved by consensus. The form was applied to the first 50 citations by all 4 reviewers to ensure clarity of the questions.

TABLE 2 Descriptive characteristics of 1190 trials in dogs or cats published between 2015 and 2020, based on information included in the citation, title, or abstract

Characteristic	Number of trials
Year of publication	
2015	186
2016	222
2017	237
2018	246
2019	230
2020 (to May 5)	69
Species evaluated	
Dogs	899
Cats	283
Dogs and cats	8
Trial type	
Parallel	933
Crossover	257

Then, reporting characteristics were evaluated based on the full text for parallel and crossover trials published in 2019 in dogs or cats using separate forms created in DistillerSR. The comprehensiveness and clarity of the questions were evaluated by all authors on 4 manuscripts. After this testing of the data extraction forms, 2 reviewers working independently assessed each trial, with any disagreements resolved by consensus. An initial question confirmed eligibility based on an evaluation of the full text. If more than 1 trial was reported within an article, only 1 eligible trial from within that article was categorized. To select this trial, the following criteria were used: if an article described 1 or more trials focused on safety or pharmacokinetics as well as trials evaluating efficacy, the trial evaluating efficacy was selected; if trials reported within the same article were conducted in both healthy animals and animals with the health condition of interest, the latter trial was used; if more than 1 trial within an article used animals with the health condition of interest, the first trial described in the methods section was used.

For all parallel trials eligible after full-text review, data were extracted on study characteristics including species evaluated in the trial, body system or condition of interest, intervention type, and outcomes evaluated in the trial (Table 3). This information was used to describe the range of clinical trials evaluated for completeness of reporting.

For evaluating reporting characteristics related to the title and abstract for each parallel trial, we created structured questions based on the recommended reporting items from the CONSORT extension for abstracts[10] with a few minor wording changes to increase the relevance to trials conducted using dogs and cats (eg, "participant" changed to "study subject"; Table 4). Based on the assumption that few authors would have designated a primary outcome in the title or abstract, we modified the question "Did authors present results for the *primary outcome*?" to "Did authors present results for *1 or more*

TABLE 3 Descriptive information on 196 trials in dogs or cats published in 2019

		Parallel trials (N = 143)	Crossover trials (N = 53)
Species	Dog	109	37
	Cat	34	16
Type of study subject	Client owned or shelter, with condition of interest	80	5
	Client owned or shelter, healthy	31	6
	Research animal, with condition of interest	2	1
	Research animal, healthy	13	31
	No information provided	17	10
Reported trial descriptors (title, abstract, methods, results)[a]	Pilot/preliminary	13	4
	Proof of concept	2	1
	Equivalence	0	0
	Noninferiority	6	0
	Superiority	0	0
	Pragmatic	0	0
	Cluster randomized	1	0
	Efficacy trial	4	0
	None of the above	120	48
Body system or condition of interest	Anesthesia/sedation	14	12
	Behavioral/anxiety	2	2
	Cardiovascular	19	12
	Dental	3	0
	Endocrine	8	2
	Ocular	7	4
	Fleas/ticks	3	0
	Gastrointestinal	18	11
	Hepatic	0	1
	Musculoskeletal	14	1
	Nervous system	8	2
	Obesity	2	0
	Other parasites	8	0
	Pain management	18	4
	Renal	1	0
	Respiratory	0	2
	Skin/hair/fur	9	0
	Urinary/reproductive	9	0
Type of intervention	Acupuncture	2	3
	Anesthesia/sedation	12	13
	Diet	4	3
	Flea/tick treatment	3	0
	Management/behavior modification	1	0
	Nonpharmaceutical[b]	35	10
	Parasite (not flea/tick) treatment	10	0
	Pain control	8	2
	Pharmaceutical[c]	53	22
	Spay/neuter methods	2	0
	Surgical techniques	8	0
	Vaccine	5	0

TABLE 3 (Continued)

		Parallel trials (N = 143)	Crossover trials (N = 53)
Outcome types evaluated[a]	Behavior	12	5
	Client satisfaction	4	1
	Flea/parasite prevalence or #/% killed	12	0
	Health[d]	57	13
	Mobility/lameness	17	0
	Pain/sedation/depth of anesthesia	48	24
	Prevalence/incidence/concentration of infectious disease agent	1	0
	Physiological	76	47
	Quality of life	7	1
	Reproductive performance	3	0
	Seizure control	3	0
	Wound healing	7	0
Explicit statement that ethical approval for the use of animals was obtained	Yes	121	49
	No	22	4
Explicit statement that Good Clinical Practices (or equivalent) were followed	Yes	16	1
	No	127	52

[a]Multiple selections for a single trial were possible, so total number may exceed number of trials.
[b]Included vitamins, minerals, herbal treatments, supplements, pro- or pre-biotics.
[c]Included antibiotics, pain medications, or licensed drugs to treat or prevent a condition.
[d]Included outcomes that did not require specialized tool to assess. Examples included duration of hospitalization, survival time, and specific health observations such as presence of urethral obstruction. Evaluations of microbiome and health also were included in this outcome category.

outcomes?". A question on whether or not the funding source was described in the title or abstract was not included, as this was felt to be a journal decision. Information on whether or not the funding source was reported anywhere in the article was collected.

For the reporting characterization of information related to objectives, methods, results, discussion, and aspects of the trial related to funding and transparency, the questions were informed by the CONSORT 2010 statement.[8,9] Reporting of each item was evaluated using 1 or more questions with fixed-choice responses (Tables 5 and 6). Questions related to CONSORT items 1a or 1b were not included because these items pertain to reporting in the title and abstract; these aspects were addressed using the CONSORT extension for abstracts,[10] as described above. Reporting of CONSORT items 2a (scientific background and explanation of rationale), 21 (generalizability of trial findings), or 22 (interpretation), also were not evaluated, as we felt that completeness of reporting of these items, although they are important to address in a trial report, would be subjective and therefore difficult to evaluate.

The same data were collected for crossover trials in dogs or cats published in 2019. The data characterization form included the same questions as the form for parallel trials, with additional questions added for 3 CONSORT items to incorporate modifications for crossover trials as proposed in the CONSORT extension for crossover trials[11] (Tables 5 and 6).

Data were summarized descriptively with cross tabulation using the pivot table function of Excel Version 16.44 (@2020 Microsoft).

3 | RESULTS

The search identified 6050 unique references, of which 1190 were eligible after title and abstract screening (Figure 1). Year of publication, species, and trial type are summarized for these trials in Table 2, based on information provided in the title and abstract. The number of trials published per year and meeting our eligibility criteria ranged from 186 to 246, and the majority of trials employed a parallel design. Of the 933 parallel trials, 897 compared treatment groups between animals and 36 trials compared treatment groups within animals (eg, comparing treatments between eyes or limbs within the same animal). Assessing bioavailability or pharmacokinetics was the sole purpose of 28 of the parallel trials, and evaluating safety was the sole purpose of 41 of the parallel trials. For the 257 crossover trials, assessing bioavailability or pharmacokinetics was the sole purpose of 56 and evaluating safety was the sole purpose of 6 trials.

There were 143 parallel trials and 53 crossover trials published in 2019 using dogs or cats and not solely evaluating pharmacokinetics,

TABLE 4 Reporting of information in the title, abstract, or both for 196 trials, based on CONSORT reporting guideline extension for abstracts (Hopewell et al., 2008)

		Parallel trials (N = 143)	Crossover trials (N = 53)
Trial identified as randomized in title	Yes	32	3
	No	111	50
Words used in the title/abstract to describe the trial	Parallel	4	0
	Crossover	0	41
	Cluster-randomized	1	0
	Noninferiority	4	0
	Equivalence	0	0
	Superiority	0	0
	Phases I, II, III, IV	0	0
	None of the above	134	12
Study subject eligibility described	Yes	75	9
	No	68	44
Study subject type described (eg, client-owned, research)	Yes	65	13
	No	78	40
Objectives or hypothesis specified	Yes	132	53
	No	11	0
Study setting described	Yes	11	4
	No	132	49
Interventions described for each group	Yes	140	52
	No	3	1
Identification of primary (or main) outcome	Yes	23	9
	No	120	44
Allocation to treatment group described	Yes—said random in abstract	118	45
	Yes—other method described	5	1
	No	20	7
Blinding described	Yes—described blinding of all tasks	0	0
	Yes—described blinding of some tasks	6	3
	Yes, but not which tasks were blinded	53	19
	No—stated blinding was not used	6	0
	No information provided	78	31
Trial status provided (complete, interim, stopped early)	Yes	1	0
	No	142	53
Number of study subjects per group provided	Yes	82	49
	No	61	4
Results provided for one or more outcomes (effect size or effects per group with measure of precision)	Yes	44	17
	No—but stated "significant" or provided *P* value cut points	85	29
	No	14	7
Presence/absence of adverse effects described	Yes	48	16
	No	95	37
General interpretation of the results provided	Yes	129	51
	No	14	2

bioavailability, or safety (Figure 1). Descriptive information for these trials is presented in Table 3. There was a wide range of body systems, intervention types, and outcome types represented by these trials. Trial descriptors, such as "proof of concept" or "non-inferiority" were rarely used in the titles and abstracts (3/196 and 6/196, respectively). Although the majority of trials (170/196) included an explicit

TABLE 5 Reporting of information in the objectives statement and methods section for 196 trials, based on CONSORT reporting guidelines[8] or the CONSORT extension for reporting of crossover trials[11]

		Parallel trials (N = 143)	Crossover trials (N = 53)
CONSORT item 2b: Specific objective or hypothesis			
Specific objective or hypothesis provided	Yes	140	53
	No	3	0
Methods			
CONSORT item 3a: Description of trial design (such as parallel, factorial) including allocation ratio			
Trial described as parallel or crossover	Yes	7	39
	No	136	14
Allocation ratio described	Yes	45	6
	No	98	47
Number of (crossover) time periods reported	Yes	NA—crossover only	52
	No		1
Duration of time periods reported	Yes	NA—crossover only	53
	No		0
Duration of washout period reported	Yes	NA—crossover only	49
	No		4
Justification for washout period length provided	Yes	NA—crossover only	7
	No		46
CONSORT item 3b: Important changes to methods after trial commencement (such as eligibility criteria), with reasons			
Important changes to methods after trial commencement described[a]	Yes, changes to intervention	12	4
	Yes, changes to sample size	4	1
	Yes, changes to recruitment or allocation	3	0
	Yes, stated there were no changes	0	0
	No information provided	126	48
CONSORT item 4a: Eligibility criteria for participants			
Eligibility of study subjects described	Yes	124	46
	No	19	7
CONSORT item 4b: Settings and locations where the data were collected			
Settings described (eg, client home, veterinary practice)	Yes	100	17
	No	43	36
Number of settings described	Yes	94	17
	No	6	0
	NA—did not describe settings	43	36
Geographic region described	Yes	79	11
	No	64	42
Dates when trial conducted described (months and years)	Yes	44	2
	No	99	51
CONSORT item 5: The interventions for each group with sufficient details to allow replication, including how and when they were actually administered			
Each intervention group explicitly described	Yes	141	53
	No	2	0
Person administering the interventions identified	Yes	63	18
	No	80	35

(Continues)

TABLE 5 (Continued)

		Parallel trials (N = 143)	Crossover trials (N = 53)
CONSORT item 6a: Completely defined prespecified primary and secondary outcome measures, including how and when they were assessed			
Primary outcome identified, or outcome provided for sample size calculation	Yes	66	24
	No	73	28
	NA—only 1 outcome	4	1
If repeated measures, primary time point identified	Yes	28	1
	No	90	39
	NA, measurements at single time	25	13
Described how outcome(s) were measured	Yes	139	53
	No	4	0
Person measuring outcome(s) identified	Yes	85	34
	No	58	19
Timing of outcome measurements(s) described	Yes	139	53
	No	4	0
CONSORT item 6b: Any changes to trial outcomes after the trial commenced, with reasons			
Whether or not any changes to outcome measures described	Yes	2	0
	No	141	53
CONSORT item 7a: How sample size was determined			
Described how sample size was determined	Yes, provided calculation	48	18
	Yes, no calculation but provided explanation	15	6
	No	80	29
Accounted for within-animal variability in calculation	Yes	NA—crossover only	2
	No		16
	NA – no sample size calculation		35
CONSORT item 7b: When applicable, explanation of any interim analyses and stopping guidelines			
Explanation of interim analysis or stopping guidelines	Yes	2	0
	No	141	53
CONSORT item 8a: Method used to generate the random allocation sequence			
Allocation described as random	Yes, called random	127	51
	Yes, called random systematic	0	0
	No, stated nonrandom	12	1
	No information provided	4	1
Random sequence generation described	Yes	80	36
	No	47	15
	NA—not described as random	16	2
CONSORT item 8b: Type of randomization; details of any restriction (such as blocking and block size)			
Any restrictions described	Yes	43	11
	No	100	42
CONSORT item 9: Mechanism used to implement the random allocation sequence (such as sequentially numbered containers), describing any steps taken to conceal the sequence until interventions were assigned			
Allocation concealed	Yes, stated or clearly described	13	3
	No information given	126	50
	No, stated not concealed	4	0
Mechanism to conceal allocation described	Yes	13	3
	No	0	0
	NA—did not conceal allocation or no information	130	50

TABLE 5 (Continued)

		Parallel trials (N = 143)	Crossover trials (N = 53)
CONSORT item 10: Who generated the random allocation sequence, who enrolled participants, and who assigned participants to interventions			
All roles in item 10 described	Yes	15	3
	No	128	50
CONSORT item 11a: If done, who was blinded after assignment to interventions (eg, participants, care providers, those assessing outcomes) and how			
Described use of blinding	Yes,	85	28
	No information, but blinding possible	42	19
	No information, but blinding not possible	4	3
	No, stated blinding not used	12	3
If blinding used, described tasks that were blinded	Yes	73	26
	No, but said "single-blind"	5	0
	No, but said "double-blind"	7	2
If blinding of tasks described, which tasks were blinded[a]	Animal caregivers	21	4
	Person administering intervention	26	8
	Investigator	29	21
	Outcome evaluator	69	25
	Statistician	4	4
CONSORT item 11b: If relevant, description of the similarity of interventions			
How blinded or similarity of interventions described	Yes	42	19
	No	43	9
	NA, not blinded	58	25
CONSORT item 12a: Statistical methods used to compare groups for primary and secondary outcomes			
Methods to compare groups described	Yes	141	53
	No	1	0
	No statistical analysis performed	1	0
CONSORT item 12b: Methods for additional analyses, such as subgroup analyses and adjusted analyses			
Control of repeated measures described	Yes	60	33
	No	57	7
	NA, all outcomes measured once	25	13
	NA, no statistical analysis	1	0
Control of clustering by site described	Yes	6	0
	No	13	0
	NA, no statistical analysis	1	0
	NA, single site	80	17
	Number of sites not provided	43	36
Methods for subgroup analysis described	Yes	11	0
	No	3	0
	NA, no subgroup analysis	129	53

[a]Multiple selections for a single trial were possible, so total number may exceed number of trials.

statement that ethical approval for the use of animals was obtained, whether or not ethical approval was obtained was not reported in 22 parallel and 4 crossover trials. The sample size for this study was not powered to test specific hypotheses and so inferential statistical testing was not performed. However, some qualitative observations on the descriptive information are provided. The majority of parallel trials were in client-owned animals (80/143 parallel trials), whereas crossover trials tended to be conducted using research animals (31/53 crossover trials). Pharmaceuticals were the most common type of intervention for both trial types (53/143 and 22/53 for parallel and

TABLE 6 Reporting of information in the results and discussion sections for 196 trials, based on CONSORT reporting guidelines[8] or the CONSORT extension for reporting of crossover trials[11]

		Parallel trials (N = 143)	Crossover trials (N = 53)
Results			
CONSORT item 13a: For each group, the numbers of participants who were randomly assigned, received intended treatment, and were analyzed for the primary outcome			
Numbers provided at site level (eg, clinic)[a]	Intended for participation	6	0
	Enrolled 1 or more subjects	11	0
	Had subjects included in analysis	7	0
	NA, single study site	81	17
	Settings not described	43	36
Numbers provided for study subjects in each intervention group[a]	Number assessed for eligibility	34	5
	Number assigned to groups	132	53
	Number receiving intervention	93	35
	Number included in the analysis	112	46
	None of the above	0	0
CONSORT item 13b: For each group, losses and exclusions after randomization, together with reasons			
Reason for sites not enrolling study subjects provided	Yes	2	0
	No	11	0
	NA—single site	81	17
	NA—reported all sites enrolled	6	0
	Settings not described	43	36
Number lost to follow-up after randomization provided by group with reasons	Yes	41	15
	No	44	8
	NA, no losses	58	30
CONSORT item 14a: Dates defining the periods of recruitment and follow-up			
Length of follow-up for study subjects described	Yes	141	51
	No	2	2
CONSORT item 14b: Why the trial ended or was stopped			
Reason for stopping early or providing interim analysis provide	Yes	2	0
	No	0	0
	NA, not stopped early or interim	141	53
CONSORT item 15: A table showing baseline demographic and clinical characteristics for each group			
Baseline demographic/clinical characteristics provided by intervention group (and time period for crossover trials)	Yes	96	0
	No	47	53
CONSORT item 16: For each group, number of participants (denominator) included in each analysis and whether the analysis was by original assigned groups			
Whether analysis was by original assigned groups described	Yes, stated intention to treat analysis	4	0
	Yes, stated per protocol analysis	2	0
	No, but stated all subjects complied with protocol	2	0
	No, but unlikely to have protocol deviations[b]	66	32
	No, but potential for protocol deviations	62	21
	Both ITT and PP analysis conducted	7	0

TABLE 6 (Continued)

		Parallel trials (N = 143)	Crossover trials (N = 53)
CONSORT item 17a: For each primary and secondary outcome, results for each group, and the estimated effect size and its precision (such as 95% confidence interval)			
Results provided only in graphical form	Yes	0	0
	No	143	53
Effects by group provided	Yes, effects by group with no measure of precision	6	1
	Yes, effects with only *P* value or *P* value cut point	19	0
	Yes, effects with confidence intervals (±*P* values)	5	2
	Yes, effects with measure of precision (±*P* values or CI)	107	50
	No	5	0
	NA, no statistical analysis	1	0
Effect sizes (eg, RR, OR, HR, mean difference) reported	Yes, with only *P* value or *P* value cut point	3	0
	Yes, with confidence intervals (±*P* values)	16	2
	Yes, effects with measure of precision (±*P* values or CI)	2	0
	No	121	51
	NA, no statistical analysis	1	0
If effect sizes given, based on within-participant comparison	Yes	NA – crossover only	0
	No		0
	Unclear		2
Included variables other than intervention and those associated with nonindependence in analysis	Yes	20 (reasons provided for 4)	5 (reasons provided for 2)
	No	122	48
	NA, no statistical analysis	1	0
CONSORT item 17b: For binary outcomes, presentation of both absolute and relative effect sizes is recommended			
Absolute and relative effect sizes presented	Yes	7	0
	No	82	23
	NA, no statistical analysis	1	0
	NA, no binary outcome	53	30
CONSORT item 18: Results of any other analyses performed, including subgroup analyses and adjusted analyses, distinguishing prespecified from exploratory			
Subgroup analysis described as exploratory	Yes	3	0
	No, but stated as planned a priori	5	0
	No	9	0
	NA, no subgroup analysis	126	53
Results reported for analysis not described in methods	Yes	11	1
	No	132	52
If yes, described as exploratory	Yes	0	0
	No	11	1
CONSORT item 19: All important harms or unintended effects in each group			
Presence or absence of harms or adverse effects reported	Yes	97	37
	No	46	16
Discussion			

(Continues)

TABLE 6 (Continued)

		Parallel trials (N = 143)	Crossover trials (N = 53)
CONSORT item 20: Trial limitations, addressing sources of potential bias, imprecision, and, if relevant, multiplicity of analyses			
Limitations presented	Yes	92	38
	No	51	15
Other information			
CONSORT item 23: Registration number and name of trial registry			
Stated that trial was included in a registry	Yes	0	0
	No	143	53
CONSORT item 24: Where the full trial protocol can be accessed, if available			
A priori trial protocol described	Yes, included as supplementary material	1	0
	Yes, provided link or information to access	1	0
	Yes, available on request	0	0
	Yes, but not how to access	22	3
	Yes, but only in context of getting ethical approval	39	18
	No or no information	80	32
CONSORT item 25: Sources of funding and other support (such as supply of drugs), role of funders			
Source of funding described	Yes	81	38
	Acknowledged contribution of materials only	7	0
	Stated no external funding	21	2
	No	34	13
Role of funders in research described	Yes	32	10
	No	56	28
	NA—no external funding or no information on source of funding	55	15
Declaration of conflict of interest provided	Yes	120	41
	No	23	12

Abbreviations: CI, confidence interval; HR, hazard ratio; ITT, intention to treat analysis; NA, not applicable; OR, odds ratio; PP, per protocol analysis; RR, risk ratio.

[a]Multiple selections for a single trial were possible, so total number may exceed number of trials.

[b]Trials where there was little potential for protocol deviations where those where the intervention was applied at a single point in time by the investigator, resulting in no real potential for protocol deviations. Thus, it was assumed that the analysis would be by intention to treat, although the trial authors did not explicitly state this.

crossover trials, respectively), with nonpharmaceuticals (35/143 and 10/53) and anesthesia or sedation interventions (12/143 and 13/53) also commonly evaluated.

Tables 4 to 6 provide the results for the reporting of both parallel and crossover trials for information provided in the title or abstract, objectives and methods, and results and discussion, respectively. The proportion of trials reporting the recommended information varied widely between CONSORT items. Some areas, such as reporting the study objectives and hypotheses, the eligibility criteria for study subjects, descriptions of the intervention groups, the method of measuring the outcome(s), the length of follow-up of study subjects, and the statistical methods used to compare groups, generally were well reported. However, other items, including the geographic region, the primary outcome, the justification for the sample size, whether or not allocation was concealed, the numbers needed to follow the flow of study subjects over the course of the trial, baseline demographics by intervention group, and whether or not there was an a priori protocol were not reported in many trials.

4 | DISCUSSION

Clinical trials are a common study design in dog and cat research and our study identified over 200 parallel or crossover trials published annually since 2016. The actual number of trials in dogs and cats published annually is much larger, given our inclusion of English language

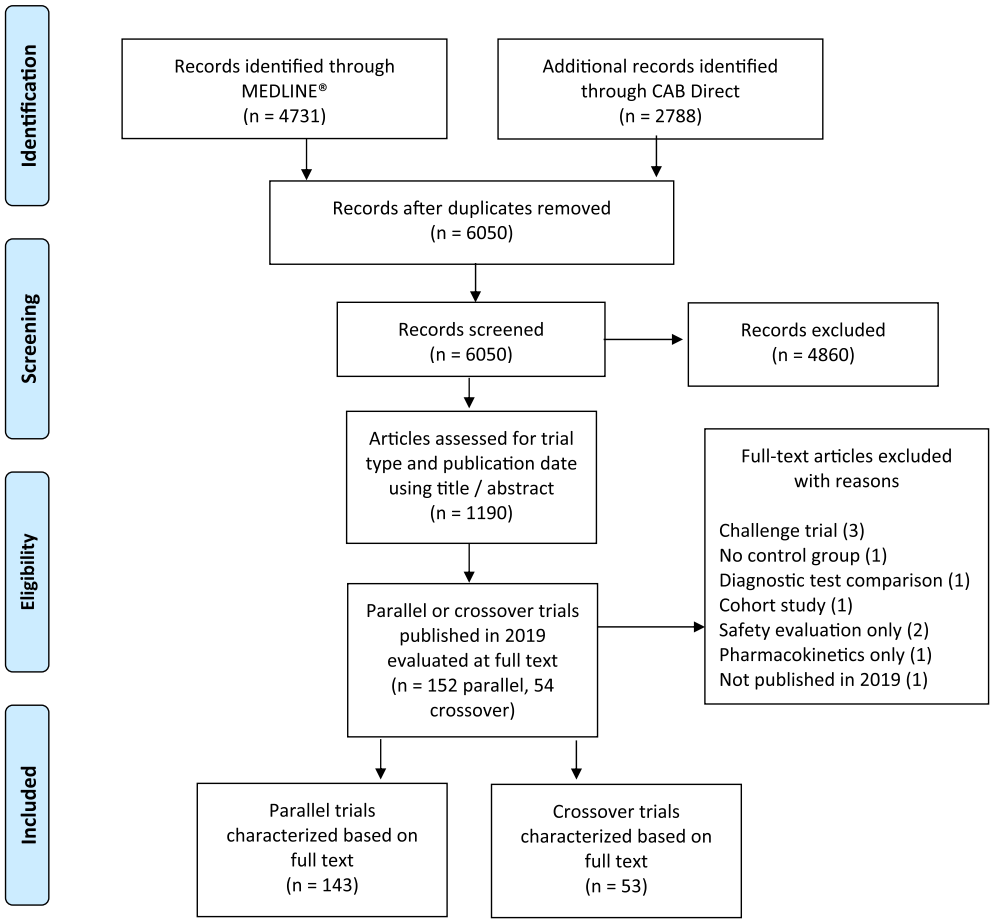

FIGURE 1 Flow of information sources for evaluating quality of reporting in clinical trials conducted in dogs and cats

trials only and our exclusion of trials in dogs and cats used as animal models of disease, challenge trials, and trials focusing solely on evaluating pharmacokinetics, bioavailability, or safety. Although the majority of the trials employed a parallel design, approximately 20% (257/1190) employed a crossover design. However, despite the importance of clear and transparent reporting of clinical trials, there are still areas where improvement is needed for both parallel and crossover trials conducted in dogs and cats. Given that clinical trials in dogs and cats involve the allocation of animals to treatments that might be inferior, there is a moral imperative to ensure that the results of the trial are usable. Comprehensive reporting is an essential first step in the ability to use the information provided by trial reports.[1] Our results suggest that, while some trial features are well reported, there still is a need to improve the completeness of reporting.

Reporting of key features in the title or abstract is critical for the identification of relevant trials for the reader. Using important trial labels such as "randomized," "parallel," or "crossover" in the title and abstract allow for efficient identification of these trial reports by individuals seeking information on interventions or for those conducting systematic reviews. Our finding of reporting deficiencies in the titles and abstract is consistent with a previous evaluation in the veterinary literature.[12] The CONSORT extension for reporting in journal and conference abstracts[10] provides guidance on what information should be included in an abstract. The organization of abstracts and, in some instances, the topics to be included in an abstract might be specified by journal editors. Nonetheless, the CONSORT extension for abstracts provides useful guidance for items that should be reported when possible. Examples of how to address all items in an abstract with short word limits are available[13] and, although the examples are from human trials, might be helpful for authors of veterinary trials.

Comprehensive reporting of the methods and results of clinical trials is important for several reasons; inadequate reporting makes it difficult to determine methodological rigor, interpret trial results, and use trial results for secondary purposes, such as systematic reviews and meta-analyses. Methodological rigor refers to the appropriate design or conduct of trials to reduce the potential for biased results.[14] Items in the CONSORT statement related to the ability of a reader to assess the risk of bias include reporting the method of allocating study subjects to intervention groups, whether allocation was concealed, the use of blinding, losses to follow-up, and whether analysis was based on intention to treat or per protocol. The frequency of reporting of these items ranged from low (20/216 described whether or not allocation was concealed) to reasonably high (158 reported random allocation to treatment group and 13 reported non-random allocation methods, with only 5 providing no information on the method of treatment allocation). Methodological rigor also includes aspects such as clear identification of a primary outcome, which should be the basis used to adequately power a trial to find meaningful differences.[9]

Our finding that approximately half of the trials evaluated (90 of 191 trials with more than 1 outcome) reported the primary outcome is higher than the 28% of cancer trials in dogs where a primary outcome was identified.[5]

The ability of the reader to interpret the results of a trial and to assess external validity (generalizability) is captured by items such as descriptions of study subject eligibility, study settings, and geographic regions, as well as explicit descriptions of all intervention groups and methods of measuring the outcomes. Although some of these features were generally well reported, it is concerning that this information still is not universally reported.

The current study did not evaluate possible reasons why researchers did not report the information that is recommended in the CONSORT guidelines. However, reasons might include lack of awareness of the guidelines or a perception that the guidelines are less relevant to trials conducted in dogs and cats. A resource for increasing awareness of, and access to, reporting guidelines for a wide variety of study designs is the Equator Network website,[15] which includes a searchable library of reporting guidelines. Similarly, the Meridian Network website[16] contains links to the smaller number of guidelines specific to animals; to date this comprises the ARRIVE statement for in vivo animal experiments,[17] the REFLECT statement for clinical trials in livestock,[18] and the STROBE-Vet statement for observational studies in animal populations.[19] Journal editors, in addition to authors and peer-reviewers, have an important role to play in driving change, including the awareness and adoption of reporting guidelines.[20] Thus, the promotion of CONSORT guidelines on the JVIM instructions to authors is laudable.

The CONSORT statement was developed for human healthcare trials, and thus is it possible that researchers perceive the guidelines as not entirely applicable to trials conducted in dogs and cats. In veterinary medicine, the REFLECT statement provides reporting guidelines specifically for reporting of clinical trials in livestock species.[18] The reporting guidelines, developed by expert consensus, were based on the CONSORT statement but included modified wording and items to address issues specific to trials conducted in livestock populations. The accompanying explanation and elaboration document provides livestock-specific examples and explanations.[21] Subsequent evaluations have shown that reporting in livestock trials has improved since publication of the RELFECT statement.[22,23] It might be warranted to consider reporting guidelines specifically tailored to clinical trials in dogs and cats.

The results of this study do not necessarily mean that trials were poorly conducted; it is possible to have a well-conducted trial that is poorly reported and a poorly conducted trial that is well reported. Devereaux et al.[24] contacted authors of published human trials and found that some investigators had used appropriate methodological approaches but did not report the information in their published trial report. In addition, the present study had potential limitations that should be considered when interpreting these results. The individuals evaluating the trials were not blinded as to author names and affiliations. However, each trial was evaluated by 2 reviewers working independently, decreasing the risk of misclassification of reporting criteria. We also only considered trials published in English. It is possible that trials reported in other languages differ in the completeness of their reporting.

5 | CONCLUSIONS

Although the CONSORT reporting guidelines for human health trials have been available for decades, there remain substantial deficiencies in reporting of clinical trials in dogs and cats. Trialists, peer-reviewers, and journal editors all have a role in improving trial reporting to maximize the value of these clinical trials.

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CONFLICT OF INTEREST DECLARATION

J. M Sargeant is a co-author of The REFLECT Statement: Methods and Processes of Creating Reporting Guidelines for Randomized Controlled Trials for Livestock and Food Safety and The REFLECT Statement: Reporting guidelines for randomized controlled trials in livestock and food safety: Explanation and elaboration. No other authors have conflicts of interest to declare.

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.

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REFERENCES

1. Moher D, Schulz KF, Altman DG, for the CONSORT Group. The CONSORT statement: revised recommendations for improving the quality of reports of parallel-group randomized trials. *Ann Intern Med*. 2001;134:657-662.
2. Altman DG, Schulz KF, Moher D, et al. The revised CONSORT statement for reporting randomized trials: explanation and elaboration. *Ann Intern Med*. 2001;134:663-694.
3. Turner L, Shamseer L, Altman DG, et al. Does use of the CONSORT statement impact the completeness of reporting of randomised controlled trials published in medical journals? A cochrane review. *Syst Rev*. 2012;1:60.
4. Sargeant JM, Thompson A, Valcour J, et al. Quality of reporting of clinical trials of dogs and cats and associations with treatment effects. *J Vet Int Med*. 2010;24:44-50.
5. Tan YJ, Crowley RJ, Ioannidis JPA. An empirical assessment of research practices across 163 clinical trials of tumor-bearing companion dogs. *Sci Rep*. 2019;9:11877.
6. Giuffrida MA, Agnello KA, Brown DC. Blinding terminology used in reports of randomized controlled trials involving dogs and cats. *J Am Vet Med Assoc*. 2012;241:1221-1226.
7. JVIM [Internet] Guidelines for preparation of manuscripts submitted to the Journal of Veterinary Internal Medicine. Available at: https://onlinelibrary.wiley.com/pb-assets/assets/19391676/NewAuthorGuidelines.pdf

8. Schulz KF, Altman DG, Moher D, CONSORT Group. CONSORT 2010 statement: updated guidelines for reporting parallel group randomized trials. *Ann Intern Med*. 2010;152:726-732.
9. Moher D, Hopewell S, Schulz KF, et al. CONSORT 2010 explanation and elaboration: updated guidelines for reporting parallel group randomised trials. *BMJ*. 2010;340:c869.
10. Hopewell S, Clarke M, Moher D, et al. CONSORT for reporting randomised trials in journal and conference abstracts. *Lancet*. 2008; 371:281-283.
11. Dwan K, Li T, Altman DG, et al. CONSORT 2010 statement: extension to randomised crossover trials. *BMJ*. 2019;366:l4378.
12. Maranville RE, Popken AK, Reynders RM, et al. Reporting quality of abstracts of veterinary randomized controlled trials. *J Am Vet Med Assoc*. 2021;258:303-309.
13. Consort group [Internet] Using the CONSORT for Using the CONSORT for Abstracts checklist: some examples. http://www.consort-statement.org/Media/Default/Downloads/Extensions/CONSORT%20Extension%20for%20Abstracts%20checklist%20examples.pdf
14. Yang LJ, Chang KW, Chung KC. Methodologically rigorous clinical research. *Plast Reconstr Surg*. 2012;129:979e-988e.
15. Equator network [Internet] Available at: https://www.equator-network.org/
16. Meridian [Internet] Available at: https://meridian.cvm.iastate.edu/
17. Kilkenny C, Browne WJ, Cuthill IC, Emerson M, Altman DG. Improving bioscience research reporting: the ARRIVE guidelines for reporting animal research. *PLoS Biol*. 2010;8:e1000412.
18. O'Connor AM, Sargeant JM, Gardner IA, et al. The REFLECT statement: methods and processes of creating reporting guidelines for randomized controlled trials for livestock and food safety. *J Vet Intern Med*. 2010;24:57-64.
19. Sargeant JM, O'Connor AM, Dohoo IR, et al. Methods and processes of developing the strengthening the reporting of observational studies in epidemiology–veterinary (STROBE-vet) statement. *J Vet Intern Med*. 2016;30:1887-1895.
20. Erb HL. Changing expectations: do journals drive methodological changes? Should they? *Prev Vet Med*. 2010;97:165-174.
21. Sargeant JM, O'Connor AM, Gardner IA, et al. The REFLECT statement: reporting guidelines for randomized controlled trials in livestock and food safety: explanation and elaboration. *Zoonoses Public Health*. 2010;57:105-136.
22. Totton SC, Cullen JN, Sargeant JM, O'Connor AM. The reporting characteristics of bovine respiratory disease clinical intervention trials published prior to and following publication of the REFLECT statement. *Prev Vet Med*. 2018;150:117-125.
23. Moura CAA, Totton SC, Sargeant JM, et al. Evidence of improved reporting of swine intervention trials in the post-REFLECT statement publication period. *J Swine Health and Prod*. 2019;27:265-277.
24. Devereaux PJ, Choi PTL, El-Dika S, et al. An observational study found that authors of randomized controlled trials frequently use concealment of randomization and blinding, despite the failure to report these methods. *J Clin Epidemiol*. 2004;57:1232-1236.

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