Use of clinical vignette questionnaires to investigate the variation in management of keratoconjunctivitis sicca and acute glaucoma in dogs

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There is little peer-reviewed research assessing therapeutic effectiveness in canine eye disease. Current treatments used in first opinion and ophthalmology referral practices are also somewhat poorly documented. The aim of this study was to investigate the current management of canine keratoconjunctivitis sicca (KCS) and acute primary angle-closure glaucoma (PACG) by veterinary surgeons. Questionnaires using clinical vignettes were administered to a cross section of general practitioners (‘GPs’) and veterinarians engaged in or training for postgraduate ophthalmology practice (‘PGs’). Similar treatment recommendations for KCS (topical cyclosporine, lubricant, antibiotic) were given by both groups of veterinarians with the single exception of increased topical antibiotic use by GPs. Treatment of acute glaucoma diverged between groups: PGs were much more likely to recommend topical prostaglandin analogues and a wider array of both topical and systemic treatments were recommended by both groups. Systemic ocular hypotensive agents were suggested infrequently. Our results suggest that treatments may vary substantially in ocular conditions, particularly in conditions for which neither guidelines nor high-quality evidence exists. This study highlights the need for novel strategies to address evidence gaps in veterinary medicine, as well as for better evaluation and dissemination of current treatment experience.

Introduction

Keratoconjunctivitis sicca (KCS) and acute primary angle-closure glaucoma (PACG) can cause significant disability in dogs.1 Incidence and prevalence data for each are not well established but risks appear to be higher in some breeds and with increasing age.23 Veterinarians routinely encounter these and other clinical conditions for which there is limited evidence available to guide clinical decision-making. Currently, there is only one veterinary pharmaceutical approved for the treatment of KCS and none for the treatment of glaucoma; it is unknown how this may affect treatment choice but could potentially result in diverse management strategies.

Numerous clinical guidelines have been developed for the treatment of human disease, in part to address unwanted treatment variation and to improve quality of care.4 In medicine, greater treatment variation is seen for interventions which have uncertain or marginal benefit and for conditions which lack clinical guidelines.5 Veterinary guidelines rely more heavily on consensus due to a small evidentiary base but areas with greater treatment uncertainty are argued to be most needful of guidance.6 While guidelines and consensus statements now exist for a number of companion animal conditions (eg, refs 7–9) we are unaware of any clinical guidelines for canine ophthalmic disease.

Clinical vignette-based questionnaires are a useful way of assessing treatment patterns and variation in clinical practice; they have been used to assess adherence to guidelines and to assess factors in clinical decision-making in medicine.10 11 Additionally, vignettes have been combined with Delphi methodology to achieve expert consensus in optimising treatment, as well as in establishing evidence gaps.12 Use of open, rather than closed, questions in vignettes has been reported to better describe clinicians’ actual practice.
patterns\textsuperscript{13} and provide insight into what is accepted current practice.

The aim of this study was to survey veterinarians about the current management of KCS and acute glaucoma. Additionally, we aimed to explore the variation in treatment among all veterinarians and between general practitioners (GP) and veterinarians with postgraduate training in ophthalmology (PG).

Materials and methods
Sampling and data collection
The target population was all members of the veterinary profession in the UK. The sampling frames were a convenience sample of veterinarians on a mailing list held by the Centre for Evidence-based Veterinary Medicine (CEVM) (identified from another survey initially approaching respondents using a list of Royal College of Veterinary Surgeons (RCVS) members who were willing to be contacted\textsuperscript{16}, and attendees at the British Association of Veterinary Ophthalmologists (BrAVO) Winter conference (2011).

A questionnaire (online supplementary file 1) was constructed consisting of 22 open and closed-ended questions across five sections as part of a student research project (Corinne Wigfall). These sections covered the diagnostic tools used for ophthalmological cases, the sources of information accessed by vets and factors considered in clinical decision-making for ocular conditions, as well as questions relating to respondent demographics (age, gender, year of graduation, ophthalmology postgraduate certification or training). The additional two sections presented two clinical vignettes—the first based on a West Highland white terrier with KCS and the second a cocker spaniel presenting with acute PACG. After each vignette, veterinarians were asked what treatments, additional investigations, long-term management and recheck advice they would give for each case. The design of the vignettes was based on ‘textbook’ cases to minimise diagnostic confusion while the associated questions were derived from a similar survey undertaken by Davies \textit{et al.}\textsuperscript{15} The questionnaire was pretested by 20 people, and piloted by eight veterinarians and three non-clinicians.

An online questionnaire was constructed and administered through cloud-based software (SurveyMonkey, California, USA) to the CEVM mailing list. Online respondents were encouraged to fill out the questionnaire by being entered into a prize draw for a £50 gift; respondents were anonymised for analysis. The online survey was initiated on October 26, 2011, and closed on November 18, 2011. A first reminder was sent two weeks after the initial email followed by a final reminder two days before the survey closed. Paper questionnaires identical in sequence and content to the online questionnaire were distributed to the attendees during one day of the BrAVO Winter conference and were collected back by three of the authors at the end of the day (November 5, 2011).

Data management and analysis
Returned online responses were downloaded to Microsoft Excel V.14.0.6 (2010 Microsoft) while paper questionnaire responses were manually entered into the same spreadsheet. Data relating to proposed treatments and diagnostic investigations were extracted from open-ended responses by one coder (CNW) and categorically classified into generic drug name and/or category, surgical or procedural interventions, diagnostic test and other patient assessments. Data relating to long-term recommendations were extracted by one coder (CNW) and classified into categories relating to prognosis, salvage treatment options, chronicity and owner communication/compliance. Suggested re-evaluation times were converted from text to numerals and where ranges were given, mean time was calculated.

Statistical analysis was performed with a commercially available statistical package (Stata IC V.13). Continuous data (age, years since graduation, recheck intervals) were assessed for normality by the Shapiro-Wilk normality test and were subsequently analysed using Mann-Whitney U tests. Chi-squared tests were used to compare categorical data between groups except when expected cell counts were ≤ 5, where the more conservative Fisher’s exact test was used. Not all respondents answered all questions; proportions are calculated using the total numbers of respondents completing each question unless otherwise indicated. Statistical significance was set at the 0.05 level; when multiple comparisons were undertaken, P values were adjusted for significance at this level with the Dunn-Bonferroni method.\textsuperscript{16} In brief, for a P value to reach significance with correction for multiple comparisons, value must be less than 0.05/k, where k is the number of comparisons. Significant P values are reported in text when not included in tables.

Results
Response rate
Of 1421 successful email invitations, 490 (34.5 per cent) online questionnaires were returned. Of those, 392 were from veterinarians engaged in small animal practice. Sixty-one paper questionnaires were returned by British Veterinary Ophthalmologist Association (BrAVO) conference attendees (total number of conference attendees unknown). Of the total number of eligible responses (453), 70 were engaged in or training for postgraduate ophthalmology practice (from here on known as ‘PGs’) while 383 were engaged in general practice (from here on known as ‘GPs’). Not all 453 respondents answered all questions within the questionnaire (Table 1).

Respondent characteristics
Sixty-three per cent of all respondents were female, with a somewhat higher proportion of men in the PG group, a difference which did not reach statistical significance. Overall median age of respondents was 37 years, with...
PGs significantly older than the GP group. Median year of qualification was significantly earlier for PGs than for GPs. Analysis stratified by gender did not eliminate age or year of qualification differences between PGs and GPs (Table 2). When participants were deanonymised by email address subsequent to analysis, credentials and practice type could be ascertained for 41 of the 70 PG respondents. Of those, 8 were RCVS Specialists in ophthalmology, 28 were designated ophthalmology certificate holders (26/28 CertVOphthal), 4 were ophthalmology certificate candidates and 1 was a non-identified certificate candidate. Overall, 88 per cent (36/41) of those successfully deanonymised were in referral practice at the time of the survey.

Keratoconjunctivitis sicca

Initial KCS treatment recommendations were offered by 399 respondents. Six different topical treatments were nominated (Table 3). The majority of both groups recommended cyclosporine (CSA) and an ocular lubricant. However, a significantly larger portion of GPs suggested using topical antibiotics. Most respondents suggested a combination of topical therapies; a wider range of combinations were offered by GPs (GPs 12 combinations, PGs 8 combinations). A majority (98 per cent) of respondents suggested one of eight different combinations of the four most common topicals (Fig 1). The top four combinations were recommended by 85.1 per cent of GPs and 90.0 per cent of PGs. PGs were significantly more likely to use topical CSA in combination with lubricant as sole treatment (chi-squared test $P=0.001$) but no other significant differences were found. Among both groups, there were few recommendations of systemic therapies: 34 veterinarians recommended a systemic non-steroidal anti-inflammatory drug (NSAID), 8 veterinarians recommended systemic antibiotics and 1 recommended systemic steroids for initial treatment.

Of 395 veterinarians who considered whether further investigation of KCS was warranted, a majority (63.8 per cent) recommended further diagnostic tests (Fig 2). The most common suggestion was fluorescein staining. PGs were significantly more likely to recommend culture, tear film breakup testing, slit lamp evaluation and rose

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**TABLE 1: Demographic and vignette question response rate**

|                           | Overall, n | Overall (%) | GP, n | GP (%) | PG, n | PG (%) |
|---------------------------|------------|-------------|-------|--------|-------|--------|
| Survey                    | 453        | 100         | 383   | 100    | 70    | 100    |
| Age                       | 330        | 72.8        | 260   | 67.9   | 70    | 100    |
| Gender                    | 332        | 73.3        | 262   | 68.4   | 70    | 100    |
| Graduation year           | 331        | 73.1        | 261   | 68.1   | 70    | 100    |
| KCS treatment             | 399        | 88.1        | 329   | 85.9   | 70    | 100    |
| Further investigation KCS | 395        | 87.2        | 319   | 85.0   | 53    | 75.7   |
| KCS diagnostics           | 252        | 55.6        | 197   | 51.4   | 55    | 78.6   |
| KCS recheck interval      | 196        | 87.4        | 136   | 85.1   | 70    | 100    |
| KCS long-term management  | 134        | 73.7        | 266   | 69.5   | 68    | 97.1   |
| Glaucoma treatment        | 130        | 72.8        | 260   | 67.9   | 70    | 100    |
| Glaucoma further investigation | 123    | 71.3        | 254   | 66.3   | 69    | 98.6   |
| Glaucoma diagnostics      | 260        | 57.4        | 191   | 50.0   | 69    | 98.6   |
| Glaucoma recheck interval | 259        | 57.2        | 206   | 53.8   | 53    | 75.7   |
| Glaucoma long-term management | 262    | 57.8        | 194   | 50.6   | 68    | 97.1   |

GP, general practitioner; KCS, keratoconjunctivitis sicca; PG, postgraduate ophthalmology practice.

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**TABLE 2: Participant responses to demographic questions, comparison between practitioner groups**

|                           | Overall, n | Overall (%) | GP, n | GP (%) | PG, n | PG (%) | P value |
|---------------------------|------------|-------------|-------|--------|-------|--------|---------|
| Gender                    |            |             |       |        |       |        |         |
| Male                      | 123        | 37.0%       | 91    | 34.7%  | 32    | 45.7%  | 0.091   |
| Female                    | 209        | 63.0%       | 171   | 65.3%  | 38    | 54.3%  |         |
| No answer given           | 121        |             | 121   |        |       |        |         |
| Age                       | 130        | 37.0        | 260   | 35.5 years | 70   | 42.0 years | 0.0002* |
| Median age (male)         | 123        | 41.0        | 91    | 40.0 years | 32   | 45.5 years | 0.0212* |
| Median age (female)       | 206        | 35.0        | 168   | 33.0 years | 38   | 38.5 years | 0.0036* |
| No answer given           | 123        |             | 124   |        |       |        |         |
| Year of qualification     | 131        | 1998        | 261   | 2001   | 70    | 1995   | 0.0001* |
| Median year qualified (all) | 123   | 1995        | 91    | 1996   | 32    | 1989   | 0.0093* |
| Median year qualified (male) | 207    | 2001        | 169   | 2002   | 38    | 1998   | 0.0055* |
| Median year qualified (female) | 122    |             | 122   |        |       |        |         |

Categorical data chi-squared test. Continuous data Mann-Whitney U test.
*Significant with Bonferroni corrected P<0.05.
GP, general practitioner; PG, postgraduate ophthalmology practice.
bengal staining when compared with GPs (P<0.003 for each item, Fisher’s exact test). Small numbers of respondents (<12 per recommendation) suggested evaluation for drug history, atopic dermatitis and neurogenic causes of dry eye. Suggested recheck intervals differed significantly between GPs and PGs. Median time suggested for first recheck was seven days (range 2–52, IQR 7–14 days) for GPs versus a median of 14 days (range 5–60, IQR 12–28 days) for PGs (Mann-Whitney U test P=0.0000).

More than 40 per cent of both groups discussed the need for long-term therapy and regular assessment. Although the questionnaire did not solicit recommendations for refractory disease, multiple respondents offered suggestions in case of treatment failure: 12 individuals recommended compounded CSA ophthalmic suspension while 6 suggested tacrolimus. Parotid duct transposition was considered by 10 respondents in each group.

Acute glaucoma
A total of 330 veterinarians made treatment recommendations for PACG. Half of all GPs indicated a desire to refer the patient with glaucoma acutely but many of those also suggested some initial treatments. Ten topical agents for PACG management were nominated (Table 4). Of those, PGs were significantly more likely to recommend a prostaglandin analogue (PGA) and steroid. GPs suggested the use of pilocarpine significantly more often than PGs. Respondents who suggested pilocarpine were not significantly different in age (Mann-Whitney U test P=0.5989), years of qualification (Mann-Whitney U test P=0.8615) or gender from other veterinarians (chi-squared test P=0.428). There were small but significant differences in choice of carbonic anhydrase inhibitor (CAI) and PGA agents selected, with a greater fraction of PGs suggesting brinzolamide and travoprost.

Nineteen combinations of the five most commonly suggested topicals were recommended by respondents (GPs 18 combinations, PGs 10 combinations). The 10 most common combinations were recommended by 55.3 per cent of GPs and 77.2 per cent of PGs. More than half (52.9 per cent) of PGs chose a PGA (typically latanoprost or travoprost) in combination with a CAI (predominately dorzolamide), with or without additional timolol and/or topical steroid. GPs nominated PGAs significantly less often and were more likely to suggest a CAI alone or in combination with topicals other than PGAs. Fewer GPs suggested CAI in fixed combination with timolol (GPs 15 of 148 CAI suggestions, PGs 13 of 50 CAI suggestions, chi-squared test P=0.001).

Many systemic therapies were also recommended (Table 5). Analgesic or anti-inflammatory drugs were suggested by a large proportion, with NSAIDs most frequently specified. Twenty individuals used a combination of products. Small numbers of respondents recommended systemic mannitol or CAI to reduce intraocular pressure (IOP). A handful of respondents recommended antihypertensive or diuretic drugs. No significant differences were found between GPs and PGs in their recommendations for systemic agents.
Of the 260 respondents who answered questions about further investigations, the majority (79.0% per cent) recommended further diagnostics but few GPs made specific diagnostic recommendations (Fig 4). PGs suggested gonioscopy, slit lamp evaluation, ocular ultrasound and Schirmer tear testing at significantly greater rates than GPs (chi-squared test P<0.001 for each test). After adjustment for access to a gonioscopy lens, PGs were still significantly more likely to recommend gonioscopy (chi-squared test P=0.000). Specific assessment for uveitis (n=7), lens luxation (n=27) and vision (n=7) was recommended by a minority of each group. A significantly higher proportion of PGs recommended evaluation of the contralateral eye (3.1 per cent GPs, 27.5 per cent PGs, chi-squared test P=0.000).

Suggested recheck intervals did not significantly differ between GPs and PGs. Median time suggested for first recheck was 1.5 days (range 1–14, IQR one to three days) for GPs versus a median of two days (range 0.6–7, IQR 1–3.5 days) for PGs. More than a third of PGs (n=25) recommended hospitalisation until IOP normalised, a significantly greater proportion than GPs (n=12, chi-squared test P<0.001).

Of the 262 respondents who gave long-term management recommendations, PGs and GPs were equally likely to discuss the need for ongoing treatment of glaucoma (11.9 per cent GPs, 17.9 per cent PGs), regular monitoring (30.4 per cent GPs, 36.2 per cent PGs) and long-term prognosis (13.4 per cent GPs, 20.3 per cent PGs). More than half of PGs (56.5 per cent) discussed evaluation, prognosis and/or prophylaxis of the contralateral eye, while significantly fewer GPs (23.7 per cent) did so (chi-squared test P=0.000).

**Discussion**

Prior work has established that substantial treatment variation may occur in the management of canine diabetes and heart failure. This study demonstrates similar variation, particularly in the treatment of PACG. We speculate that this variation may be driven by knowledge gaps influenced by one or more of the following factors: lack of evidence-based and/or consensus guidelines, access to information, or differences in caseload and/or practice setting.

For KCS, fairly robust evidence (grade I) exists for topical CSA efficacy in prospective clinical trials and an approved veterinary ophthalmic preparation has been available for more than two decades. Frequent nomination of CSA for KCS treatment likely reflects acceptance of efficacy and incorporation into standards of care.
The preference for CSA over tacrolimus may be driven by CSA’s availability as a licensed veterinary product as well as current evidence which suggests equal efficacy of CSA and tacrolimus for treatment-naïve KCS. Similarly, there was general agreement in favour of topical lubricant. Prior to the introduction of CSA, lubricants were the mainstay of KCS medical therapy and, extrapolating from human dry eye, may be reasonably expected to provide some symptomatic relief and corneal protection.

Apart from CSA, most topicals used in KCS have limited published evidence for efficacy and this may account for wider variation in their recommended use. There are sparse data regarding the prevalence of secondary infection with conflicting recommendations for antibiotic use in KCS, and, extrapolating from human dry eye, may be reasonably expected to provide some symptomatic relief and corneal protection.

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While broad general agreement was found for KCS management, treatment suggestions for PACG were more varied. GPs nominated topical PGAs significantly less frequently than did PGs while use of CAIs was more similar between the two groups. There is reasonable evidence (grade II) for both PGA and CAI efficacy for IOP reduction in beagles with open-angle glaucoma, with PGAs offering superior duration and magnitude of IOP reduction. However, no clinical trials assessing safety or efficacy of these agents alone or in combination have been reported for the more common syndrome of PACG reviewed by refs. Topical PGAs are preferred over systemic agents in achieving IOP reduction by some authors, a view that was paralleled by our results. Clinical uncertainty in recognising PGA contraindications may account for the lower rate of GP recommendation. However, other factors may play a role in differential recommendations: pilocarpine has similar contraindications yet was recommended by a number of GPs. It is striking that no PG recommended pilocarpine; veterinary ophthalmologists appear to discourage pilocarpine due to ocular irritation and perceived superiority of other ocular hypotensives.

Choice of topical PGA and CAI also varied between GP and PG groups with the latter group nominating travoprost and brinzolamide significantly more frequently. Reasons for product choice were not elicited in our questionnaire and we are unaware of any comparative efficacy trials between dorzolamide and brinzolamide, or between latanoprost and travoprost, in acute canine glaucoma; however, brinzolamide is suggested to result in less ocular irritation relative to dorzolamide. Likewise, more PGs recommended a topical steroid. Although we did not elicit the clinical reasoning behind treatment suggestions, steroids may have been recommended due to the putative role of inflammation.

### TABLE 5: Systemic acute glaucoma therapies suggested by participants

| Treatments                      | Overall, n | Overall (%) | GP, n | GP (%) | PG, n | PG (%) | P value |
|--------------------------------|------------|-------------|-------|--------|-------|--------|---------|
| Pain/anti-inflammatory          |            |             |       |        |       |        |         |
| NSAID                          | 155        | 47.0        | 118   | 45.4   | 37    | 52.9   | 0.266   |
| Unspecified analgesia          | 25         | 7.6         | 24    | 9.2    | 1     | 1.4    | 0.038†  |
| Opioid or tramadol             | 19         | 5.8         | 10    | 3.8    | 9     | 12.9   | 0.004*  |
| Glucocorticoid                 | 4          | 1.2         | 3     | 1.2    | 1     | 1.4    | 1.000†  |
| All pain/anti-inflammatory     | 183        | 55.5        | 144   | 55.3   | 39    | 55.7   | 0.961   |
| IOP agents                     |            |             |       |        |       |        |         |
| Intravenous mannitol           | 34         | 10.3        | 26    | 10.0   | 8     | 11.4   | 0.727   |
| Oral CAI                       | 17         | 5.2         | 16    | 6.2    | 1     | 1.4    | 0.157†  |
| Hypotensives/diuretics         |            |             |       |        |       |        |         |
| Antidiuretic                   | 2          | 0.6         | 0     | 0.0    | 2     | 2.9    | 0.044†  |
| ACE inhibitor                  | 1          | 0.3         | 1     | 0.4    | 0     | 0.0    | 1.000†  |
| Furosemide                     | 4          | 1.2         | 4     | 1.3    | 0     | 0.0    | 0.582†  |
| Referral                       | 133        | 40.3        | 130   | 50.0   | 3     | 4.3    | 0.000*  |

*Significant with Bonferroni corrected P<0.05, chi-squared test unless otherwise indicated.
†Fisher’s exact test.

CAI, carbonic anhydrase inhibitor; GP, general practitioner; IOP, intraocular pressure; NSAID, non-steroidal anti-inflammatory drug; PG, postgraduate ophthalmology practice.
in both genesis and progression of PACG\(^{41,42}\); steroids may exacerbate ocular hypertension in cats and dogs but the response may vary by individual and with the concurrent use of PGA.\(^{43-46}\) However, we are unaware of any studies assessing the use of steroids in PACG (apart from prophylaxis in unaffected but at-risk eyes). As would be anticipated, PGs recommended a greater number of specific ophthalmic diagnostics. GP suggestions for additional investigation generally agreed with PG recommendations when the suggested test was inexpensive and did not require specialised equipment or expertise. In particular, gonioscopy may be difficult to master without routine practice and we are not aware of any readily available training resources for GPs.

Recheck intervals and judgement regarding natural history and prognosis of KCS and glaucoma were generally concordant between both groups with one exception: recheck intervals for KCS were significantly shorter for GPs than for PGs. Topical CSA typically lags three to four weeks for maximal increase in tear production.\(^{21}\) The shorter median interval suggested by GPs may reflect severity differences in initial presentation, misunderstanding of CSA pharmacodynamics, decreased clinical confidence, or a variety of other factors not captured in this survey. Alternatively, GP versus PG clinic proximity may affect recheck intervals amenable to clients; however, the similarity of suggested glaucoma recheck intervals between the two groups argues against client convenience as a driving factor.

Veterinarians in primary practice are required to have proficiency in multiple domains and may have limited access to literature unless affiliated with academic practice; availability of veterinary ophthalmologist advice may also vary due to geographic, social network and practice characteristics. Although management guides used by GPs uniformly recommend CSA and provide algorithms for the treatment of KCS, most PACG references are less directive in treatment recommendations and typically provide a more general pharmacologic review, with referral often recommended as the preferred treatment strategy.\(^{47-49}\) We speculate that the wider range of recommendations for PACG encountered among our GP respondents may reflect a lack of clear and concise treatment guidelines for this condition; guidance which may be particularly needed for cases which cannot be referred. PGs in this survey also varied in their treatment recommendations, particularly with respect to the use of combinations of topical agents; variable use of steroids and antibiotics in the case of KCS, as well as agents combined with PGAs in PACG, suggests treatment uncertainties which may need additional data to resolve. We suggest that establishing current practice in treating companion animal ocular disease may at least allow for benchmarking of individual practitioners against their colleagues. Additionally, these surveys can both highlight clinical questions of high priority and identify areas needful of consensus guidance when evidence is lacking. We suggest incorporation of Delphi or similar anonymised methods in formulating veterinary ophthalmology guidelines.\(^{50}\) Adherence, credibility and feasibility of consensus guidelines are suggested to improve when GPs are included on consensus panels.\(^{51-54}\) Assemblage of electronic cohort data from both referral and first opinion practices, as well as consideration of multicentre pragmatic clinical trials, may be cost-effective paths to generating better and externally valid evidence.

**Study limitations**

This survey was distributed to a subset of RCVS registered veterinarians who had expressed willingness to be contacted by the CEVM, as well as to attendees at an ophthalmology meeting. Additionally, although the majority of respondents completed the survey via a web-based instrument, questionnaire format (paper v web based) may have resulted in qualitative or quantitative differences in responses. Several levels of self-selection bias may have been introduced: veterinarians who were willing to be contacted may have a greater interest in evidence-based medicine while veterinarians who responded to the web-based survey may have better access or understanding of a web-based instrument. Respondents were more likely to be female and newer graduates than RCVS members in total; a contemporary survey of RCVS members found a median qualification year of 1991, with approximate gender parity in registered members.\(^{55}\) As with any vignette-based survey, conformity of recommendations to actual practice cannot be established.

**Conclusion**

This survey of veterinarians in the UK found variation in the treatment of KCS and PACG between practitioners. Variation in management may be driven by a limited evidence base, lack of clinical guidelines, heterogeneous training and practice settings, and clinical confidence or interest on the part of respondents. Additionally, greater treatment variation was found in management of PACG, a condition for which no approved veterinary products are available. Further work is needed in assessing factors responsible for treatment variation and in optimising resources and strategies for building and disseminating evidence-graded, relevant diagnostic and treatment recommendations to practitioners.

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**Competing interests**

None declared.

**Ethics approval**

Ethical approval for the study was received from the Ethics Committee of the School of Veterinary Medicine and Science at the University of Nottingham.
References

1. CHESTER Z, CLARK WT. Coping with blindness: a survey of 50 blind dogs. Vet Rec 1988;123:668–71.
2. GELATT KN, MACKAY EC. Prevalence of the breed-related glaucomas in pure-bred dogs in North America. Vet Ophthalmol 2000;3:303–10.
3. SANCHEZ RF, INOCENTO G, MOULD J, et al. Canine keratoconjunctivitis sicca: disease trends in a review of 229 cases. J Small Anim Pract 2007;48:211–7.
4. TIMMERMANS S, MAUCK A. The promises and pitfalls of evidence-based medicine. Fam Pract 2005;22:128–32.
5. SKINNER J. Causes and consequences of regional variations in health care. Handbook of health economics 2011:2:45–93.
6. POLZIN DJ, COWGILL LD. Development of clinical guidelines for management of glomerular disease in dogs. J Vet Intern Med 2013;27 Suppl 1:52–54.
7. ATKINS C, BONAGURA J, ETTINGER S, et al. Guidelines for the diagnosis and treatment of canine chronic valvar heart disease. J Vet Intern Med 2009;23:1142–50.
8. PODELL M, VOLK HA, BERENDT M, et al. 2015 ACVM Small Animal Consensus Statement on Seizure Management in Dogs. J Vet Intern Med 2016;30:677–90.
9. GUYVY T, DEBOER DJ, FAVRIT C, et al. Treatment of canine atopic dermatitis. 2010 clinical practice guidelines from the International Task Force on Canine Atopic Dermatitis. Vet Dermatol 2010;21:231–48.
10. PEBBODY IW, LUCK J, GLASSMAN P, et al. Measuring the quality of physician practice: using clinical vignettes: a prospective validation study. Ann Intern Med 2004;141:771–80.
11. VELOJSKI T, TAI S, EVANS AS, et al. Clinical vignette-based surveys: a tool for assessing physician practice variation. Am J Med Qual 2005;20:151–7.
12. ROSE CM, KAGAN AR. The final report of the expert panel for the radiation oncology bone metastasis work group of the American College of Radiology. Int J Radiat Oncol Biol Phys 1998;40:1117–24.
13. PHAN T, ROY C, MARIETTE X, et al. Effect of response format for clinical vignettes on estimates of treatment efficacy. Vet Comp Med 2016;31:194–202.
14. NIELSEN TD, DEAN RS, ROBINSON NJ, et al. Characterization of a fixed combination of dorzolamide-timolol to monotherapy with timolol or dorzolamide on IOP, pupil size, and heart rate in glaucomatous dogs. Vet Ophthalmol 2006;9:245–9.
15. MASLANKA T. A review of the pharmacology of carbonic anhydrase inhibitors for the treatment of glaucoma in dogs and cats. Vet J 2015;203:278–84.
16. MASLANKA T. Pharmacology of topical prostaglandin F2α analogs and their place in evidence-based medicine to the treatment of glaucoma in small animals. J Vet Pharmacol Ther 2015;38:105–12.
17. ALARIO AF, STRONG TD, PIZZIBANI S. Medical Treatment of Primary Canine Glaucoma. Veterinary Clinics of North America. Small Animal Practice, 2015:1235–59.
18. DEES DD, FRITZ KJ, MACLAREN NE, et al. Efficacy of prophylactic antiglaucoma and anti-inflammatorials medications in canine primary angle-closure glaucoma: a multicenter retrospective study (2004-2012). Vet Ophthalmol 2014;17:195–200.
19. REILLY CM, MORRIS R, DUBIELZIG RR. Ocular goniodysgenesis-related glaucoma: a morphologic review of 100 cases looking at inflammation and pigment dispersion. Vet Ophthalmol 2005;8:253–8.
20. HERRING IP, HERRING ES, WARD DL. Effect of orally administered hydrocortisone on intraocular pressure in nonglaucomatous dogs. Vet Ophthalmol 2004;7:381–4.
21. GELATT KN, MACKAY EC. The ocular hypertensive effects of topical 0.1% dexamethasone in Beagles with inherited glaucoma. J Ocul Pharmacol Ther 1998;14:57–66.
22. KAHANE N, BDOH-ABRAM T, RASKANSKY H, et al. Clinical evaluation of 1% cyclosporine for treatment of keratoconjunctivitis sicca in dogs. J Vet Ophthalmol 2007;50:1039–42.
23. KILAND JA, RUTKOWSKI LE, et al. Effect of topical corticosteroid administration on intraocular pressure in normal and glaucomatous cats. Vet Ophthalmol 2006;9:199.Suppl 11:69–76.
24. CLODE A. Canine keratoconjunctivitis sicca. NAVC Clinician’s Brief 2015:81–5.
25. COUTZ CMH. Canine glaucoma. NAVC Clinician’s Brief 2010:24–7.
26. KEINSTEIN S, RAWSON A, ALIBAUGH R. Canine glaucoma: medical and surgical treatment options. Compendium (Waltham, MA) 2013:4, 34–8; quiz 2009,459.
27. Jones H, Hunter D. Consensus methods for medical and health services research. BMJ 1995;311:376–80.
28. ALLAN GM, KRAUT R, CRAWSHAY A, et al. Contributors to primary care guidelines: what are their professions and how many of them have conflicts of interest? Can Fam Physician 2015;61:52–8.
29. CARLSSEN B, NORHEIM OF. “What lies beneath it all?”—an interview study of GPs’ attitudes to the use of guidelines. BMC Health Serv Res 2008;8:218.
30. RASHIDIAN A, ECCLES MP, RUSSELL I. Falling on stony grounds? A qualitative study of implementation of clinical guidelines’ prescribing recommendations in primary care. Health Policy 2008;85:148–61.
31. CARLSSEN B, GLENTON C, POPE T. Thou shalt versus thou shalt not: a meta-synthesis of GPs’ attitudes to clinical practice guidelines. Br J Gen Pract 2007,57:971–8.
32. ROBERTSON-SMITH G, ROBINSON D, HICKS B, et al. The 2010 RCVS survey of the UK veterinary and veterinary nursing professions. Brighton, UK: Institute for Employment Studies, 2010.