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ORIGINAL RESEARCH

# Applying clinical audit for quality improvement in canine dystocia cases seen at a UK primary-care emergency practice

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## Abstract

**Background:** The paucity of published veterinary clinical audits suggests that clinical audit is an under-used tool for quality improvement (QI) in the veterinary profession. Therefore, a continuous QI process was designed and implemented at a UK multisite small animal emergency practice, focusing on audit of clinical management of canine dystocia.

**Methods:** Data collection phases were undertaken in 2014, 2019 and 2021, with intervening knowledge dissemination activities. Nine variables relating to clinical management of canine dystocia were selected as audit criteria in the initial dataset, and 21 variables were measured in each subsequent phase.

**Results:** Between 2014 and 2021, statistically significant increases ($p < 0.05$) were demonstrated in recording of bodyweight, use of diagnostic imaging, use of ultrasonography, recording of fetal heart rates, use of calcium gluconate, and use during caesarean section of intravenous fluid therapy, multimodal analgesia, full agonist opioids, paracetamol and local anaesthesia. Statistically significant decreases were demonstrated in median first quantity and median first dose of oxytocin, and in the use of NSAIDs during caesarean section. A clinical audit planning template was created for future audits.

**Limitations:** Typical case presentation and management of canine dystocia cases may vary between dedicated emergency and non-emergency primary-care settings.

**Conclusion:** This study demonstrates the feasibility of large-scale veterinary clinical audit and suggests that the application of the clinical audit process promotes learning within the veterinary team and improved clinical outcomes.

KEYWORDS
canine dystocia, clinical audit, electronic patient record, knowledge dissemination, primary care, quality improvement

## INTRODUCTION

Quality improvement (QI) describes the application of systematic approaches to investigating existing processes and seeking to improve them measurably.[1] Although pioneered within Japanese industry,[2] QI covers a broad umbrella of activity within healthcare and has been described as 'the combined and unceasing efforts of everyone—to make the changes that will lead to better patient outcomes (health), better system performance (care) and better professional development (learning)'.[3] QI processes can support good clinical governance, enabling the fulfillment of professional responsibilities, and can count towards RCVS continuing professional development requirements.[4–6]

A QI framework featuring five key tools has been suggested for the veterinary profession.[1] Of those, clinical audit, a process in which named current activities are systematically reviewed and compared against explicit criteria, relevant changes are introduced, and the resultant impacts are measured,[7] encourages integration of relevant evidence-based veterinary medicine within clinical practice.[8,9] Audit of clinical procedures in daily practice is a requirement for all practices that are members of the RCVS Practice Standards Scheme.[10]

In human medicine, clinical audit has been placed at the heart of clinical governance within the National Health Service (NHS) since 1989, and all doctors working in primary care are now required to participate in clinical audit.[11,12] Despite widespread uptake, clinical audit has shown mixed results for contributing to meaningful change in human healthcare.[12–14] Reported reasons include poor project design, failure to continue the audit cycle or ineffective management of change leading to disengagement of local staff.[12] Furthermore, audits may be variably beneficial in differing organisations or departments.[15] With a reported organisational failure to adopt a coherent or sustained approach to QI,[16] the danger is that QI interventions may be seen erroneously as 'magic bullets' that will improve healthcare regardless of the numerous confounding environmental factors.[17] It is increasingly recognised that the commitment of local staff is required to embed clinical audit across the NHS.[12,18]

In the veterinary literature, uptake of clinical audit has been slower and less widespread.[19] Barriers to success of the clinical audit process in veterinary medicine have been reported to include weak project design, use of a variety of reporting methods, which may reduce visibility of published audits, and a paucity of veterinary evidence-based guidelines to support benchmarking against explicit criteria.[7,19,20] Additionally, as reported in human healthcare, limited resources, limited expertise or advice, dysfunctional relationships between group members, lack of an overall plan and perceived lack of management support may contribute to poorly effective veterinary clinical audit processes.[21] While the process of clinical audit is intended as an iterative cyclical activity, assessing the impact of changes by repeating data collection phases is often missed.[8,22] Conversely, ease of data collection, sharing timely results and outcomes, protected time to undertake audit, and appropriate support and clinical engagement to empower local teams and facilitate change may promote greater success in the clinical audit process.[21] Directly involving team members in the planning and implementation of change may also assist in creating a positive learning culture within the veterinary team.[8,9]

In summary, it is increasingly recognised that human-centred approaches promote greater success and gains from the clinical audit process.[8,9,12,21] While training on the concept of clinical audit is available from RCVS Knowledge,[23] there remains a scarcity of veterinary literature describing the practical implementation and evaluation of clinical audit in the real-world primary-care setting.

Using dystocia as a clinical example, the current audit aimed to report the opportunities and challenges associated with designing and implementing a clinical audit as part of a QI project in primary-care emergency practice. The final report could offer a template for others in primary-care practice to implement clinical audit as part of their QI projects, and may encourage increased and more enthusiastic uptake of QI, and specifically clinical audit, across the veterinary profession.

Specific objectives of the QI project were to mobilise an elective interprofessional group to design and implement a continuous QI process for the clinical management of canine dystocia cases at Vets Now, to gather data on fetal monitoring and medical and surgical management of these cases, to disseminate gained information to internal and external stakeholders, to evaluate engagement of Vets Now staff with the QI knowledge dissemination activities and to generate a template to assist with the integration of clinical audit into daily clinical life both within Vets Now and also for other primary-care practices.

## METHOD

The clinical audit of canine dystocia cases at Vets Now is summarised in Figure 1. Vets Now treats companion animal patients registered at over 1000 primary-care practices, providing out-of-hours emergency care at over 60 sites across the UK.[24] Records on clinical care are documented electronically using a bespoke practice manage system (Helix practice management system). Aspects of clinical presentation and management are recorded in the free-text clinical notes, and by coding provisional diagnoses using VeNom Coding standardised terminology.[25]

### Audit Phase 1 (2014)

A merged anonymised dataset was analysed from all 701 canine dystocia cases identified within a population of 18,758 female entire dogs seen at Vets Now between 1 September 2012 and 28 February 2014. In addition to providing data for a clinical audit cycle, specific objectives of this work were to report the prevalence and risk factors for dystocia in the emergency-care caseload of entire bitches,[26] and to explore the clinical management and outcomes of these dystocia cases with particular focus on caesarean section.[27] The dataset was generated within the VetCompass programme[28] following searches across five data fields of the electronic patient records, using terms related to dystocia (Appendix 1). A dystocia case required: (a) evidence on Helix of presentation for emergency clinical care related to whelping; and (b) assessment of the bitch by the attending veterinary surgeon as having at least part of one puppy retained internally.[27] The results were aggregated and randomly ordered using the Rand function within

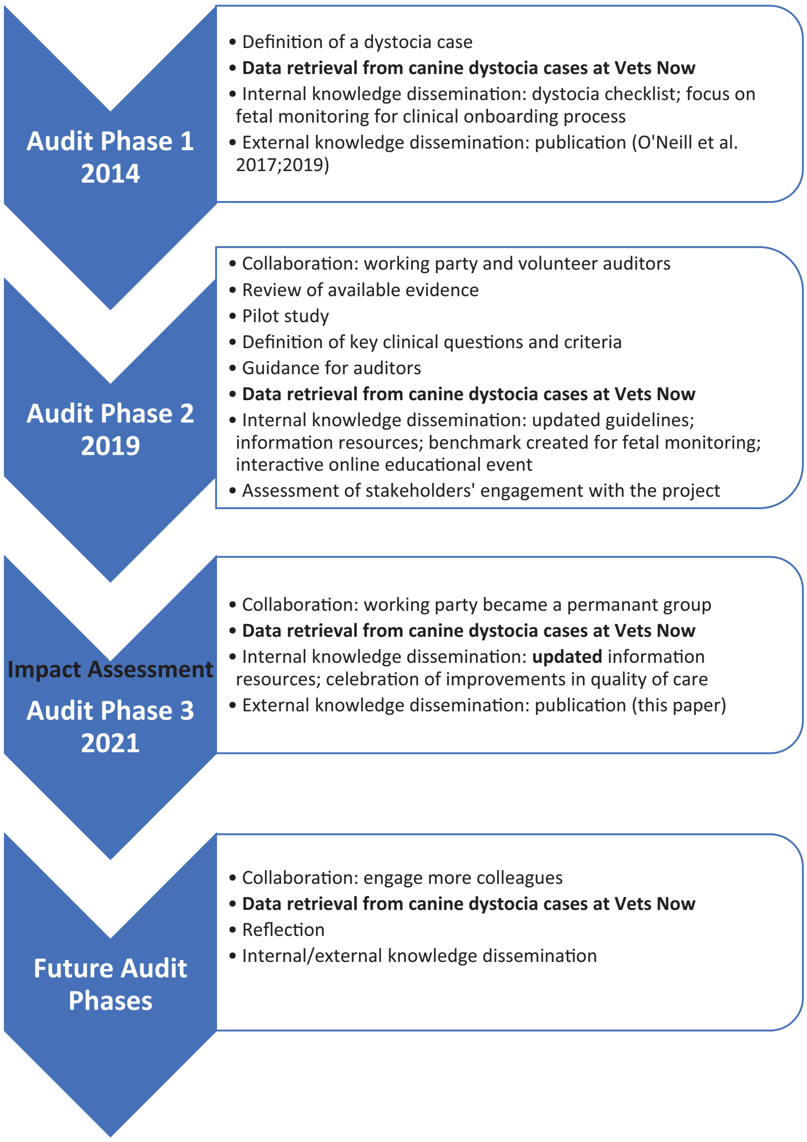


**FIGURE 1** Summary of the clinical audit process of canine dystocia cases at Vets Now

Microsoft Excel. Univariable followed by multivariable binary logistic regression modelling evaluated risk factors for association with caesarean section.[26] Model development used manual backwards stepwise elimination with clinic attended considered as a random-effect and pair-wise interaction effects were evaluated for the final model variables. The Hosmer–Lemeshow test statistic and the area under the receiver operating characteristic curve were used to evaluate model fit (non-random-effect model). Statistical significance was set at $p < 0.05$. Data on nine key clinical outcomes were extracted and reported (Table 1). Variables were analysed using the chi-square and Mann–Whitney *U*-tests.[27]

It was demonstrated that bodyweight recording, diagnostic imaging uptake, ultrasonography uptake, radiography uptake, oxytocin usage, oxytocin dosing, calcium gluconate usage and caesarean section uptake could be objectively measured by examining electronic patient records of canine dystocia cases. A checklist of specific safety-critical actions for the clinical management of canine dystocia cases was created for Vets Now staff (Appendix 2). Updated information on canine dystocia and fetal monitoring was provided to new Vets Now employees during the clinical onboarding process (Appendix 3). Knowledge gained from this Audit Phase 1 was disseminated externally through the publication of papers and infographics in the veterinary literature on prevalence, risk factors, clinical management and outcomes in canine dystocia cases.[26–29]

## Audit Phase 2 (2019)

All clinical staff at Vets Now were invited to participate in further data collection from canine dystocia cases. Engagement incentives included an opportunity to improve canine welfare related to maternal and neonatal outcomes, gain professional growth and contribute to a clinical audit that is part of continuing professional development requirements. Twenty-one clinical auditors were recruited. The literature was searched for evidence-based standards or evidence relating to the clinical management of canine dystocia, and for published clinical audits of companion animal veterinary care in general, using online searches of Google Scholar, RCVS Library and PubMed. A pilot

**TABLE 1** Key clinical questions on the clinical management of canine dystocia to be answered from electronic patient records during three audit cycles of canine dystocia cases seen at Vets Now between 1 September 2012 and 25 August 2021

| Clinical questions to be answered on the clinical management of canine dystocia cases from their electronic patient records | Phase 1 (1 September 2012–28 February 2014) | Phase 2 (1 June 2018–31 May 2019) | Phase 3 (1 June 2021–25 August 2021) |
|---|---|---|---|
| Was bodyweight recorded? | ✓ | ✓ | ✓ |
| Was diagnostic imaging performed? | ✓ | ✓ | ✓ |
| Was radiography performed? | ✓ | ✓ | ✓ |
| Was ultrasonography performed? | ✓ | ✓ | ✓ |
| Were fetal heart rates measured and recorded? | | ✓ | ✓ |
| Was oxytocin administered? | ✓ | ✓ | ✓ |
| Oxytocin median first quantity (iu/dog)? | ✓ | ✓ | ✓ |
| Oxytocin median first dose (iu/kg)? | ✓ | ✓ | ✓ |
| Was calcium gluconate administered? | ✓ | ✓ | ✓ |
| Was caesarean section performed? | ✓ | ✓ | ✓ |
| Caesarean section: was intravenous fluid therapy administered? | | ✓ | ✓ |
| Caesarean section: were multiparameter monitor findings recorded? | | ✓ | ✓ |
| Caesarean section: was opioid analgesia administered? | | ✓ | ✓ |
| Caesarean section: was timing of opioid recorded? | | ✓ | ✓ |
| Caesarean section: was opioid administered pre-ex utero? | | ✓ | ✓ |
| Caesarean section: was opioid administered post-ex utero? | | ✓ | ✓ |
| Caesarean section: was full agonist selected as opioid? | | ✓ | ✓ |
| Caesarean section: was NSAID administered? | | ✓ | ✓ |
| Caesarean section: was paracetamol administered? | | ✓ | ✓ |
| Caesarean section: was local anaesthesia administered? | | ✓ | ✓ |
| Caesarean section: was multimodal analgesia administered? | | ✓ | ✓ |

audit collected data on 40 dystocia cases to develop a standard operating procedure for further data collection and recording. An online authoring tool, Elucidat,[30] was used to create training materials for the data collection procedure, highlighting technical, professional and clinical considerations, and the spirit of the audit in the context of a learning culture (Appendix 4).

To broaden the scope of the audit, the number of clinical questions to be answered from the data was expanded from nine to 21 (Table 1), to include further details of surgical and pharmacological management.

A structured query language search was used to extract anonymised fields of electronic patient record data from the Helix practice management system for all 753 canine dystocia cases seen at Vets Now between 1 June 2018 and 31 May 2019. The search terms and case randomisation mirrored those used for Audit Phase 1. Cases were allocated randomly between the clinical auditors and a systematic approach was used to review the clinical records and extract data from each case (Appendix 5). Results were merged and variables were analysed using chi-square and Mann–Whitney *U*-tests.[31]

A working group of three veterinary surgeons and a veterinary nurse met remotely for an average of 60 minutes once or twice a month between November 2020 and May 2021 to establish a strategy for knowledge dissemination to stakeholders. Input was sought from the Vets Now Professional Standards Director and the National Emergency Critical Care Lead for the process of updating clinical guidelines and creating new information resources for improved management of canine dystocia cases. A pragmatic consensus-driven standard for the recording of fetal heart rates was sought, and a long-term target for achieving this in 75% of canine dystocia cases was suggested.

Infographic 1 (Appendix 6), summarising results from the first two phases of the dystocia audit, was disseminated throughout the organisation. A webinar and discussion panel event were held, with an invitation extended to all clinical staff at Vets Now (Appendix 7). Live webchat and a web-based survey system were used to encourage interaction between participants.[32] Time was allocated for an interactive session to offer guidance on specifically challenging cases or issues. Staff were also encouraged to submit questions by email prior to the event.

Information resources on the Vets Now online learning platform[33] were expanded to include a recording of the webinar, Infographic 1 (Appendix 6), updated dystocia checklists (clinical management and telephone triage: Appendices 2 and 8), a caesarean-section postoperative management guideline (Appendix 9) and an early neonatal survival guideline including neonatal resuscitation and appearance, pulse, grimace, activity, respiration (APGAR) scoring (Appendix 10). Data on numbers of learners who accessed each information resource in the 6 months following the knowledge dissemination activities were gathered.

## Audit Phase 3 (2021): Impact assessment

Power calculation estimated that 288 canine dystocia cases were needed to detect an increase in ultrasonography uptake from 45% to 55%, with 0.5% acceptable margin of error at 95% confidence level.[34] Data were examined from 302 canine dystocia cases seen at Vets Now clinics between 1 June and 25 August 2021, from an overall population of 9193 female entire dogs. Audit criteria and processes mirrored those used for Audit Phase 2, with an interval of 4 weeks between the Phase 2 knowledge dissemination activities and the beginning of the Phase 3 sampling timeframe. Case randomisation and data analysis mirrored Phases 1 and 2. Infographic 2 (Appendix 11), summarising the results of the impact assessment, was disseminated throughout the organisation to update staff and celebrate improvements in quality of care. Input from clinical leaders across Vets Now was sought to assist with the planning and implementation of further development of educational resources, including a video for APGAR scoring of neonates and an updated guideline for analgesia in caesarean section (Appendix 12). The current paper describing this QI project was prepared and submitted for publication.

# RESULTS

In Audit Phase 1, 701 dystocia cases were recorded among 18,758 female entire canine cases seen at Vets Now clinics between 1 September 2012 and 28 February 2014, with a dystocia prevalence of 3.7% (95% confidence interval [CI] 3.4–4.0). Breed data were available for 668 of 701 (95.3%) cases. Of those, the most common breeds diagnosed with dystocia were Chihuahuas ($n = 75$, 10.0%), Staffordshire Bull Terriers ($n = 59$, 8.4%), Jack Russell Terriers ($n = 43$, 6.1%) and crossbreeds ($n = 40$, 5.7%). Age data were available in 659 of 701 ($n$ = 94.0%) cases, and the median age at dystocia was 3.0 years (interquartile range [IQR] 2.0–4.0, range 0.7–14.0). Of 1907 puppies recorded as being born at Vets Now, 1443 were recorded as being alive at discharge (75.7%), with an overall neonatal mortality of 24.3%. Table 2 displays results of the audit of nine variables relating to clinical management of the 701 canine dystocia cases.

In Audit Phase 2, 753 dystocia cases were identified from 24,431 female entire canine cases seen at Vets Now clinics between 1 June 2018 and 31 May 2019, with a dystocia prevalence of 3.1% (95% CI 2.9–3.3). Breed data were available for 709 of 753 (94.1%) cases. Of those, the most common breeds diagnosed with dystocia were French Bulldogs ($n = 143$, 19.0%), Chihuahuas ($n = 83$, 11.0%), crossbreeds ($n = 48$, 6.4%) and Pugs ($n = 39$, 5.2%). Age data were available in 693 of 753 (92.0%) cases. The median age at dystocia was 4.0 years (IQR 2.0–5.0, range 0.7–13.0). Of 1922 puppies recorded as being born at Vets Now, 1396 were recorded as alive at discharge (72.6%), showing an overall neonatal mortality of 27.4%. Table 2 displays results of the audit of 21 variables relating to clinical management of the 753 canine dystocia cases.

In Audit Phase 3, 302 dystocia cases were recorded among 9193 female entire cases seen at Vets Now clinics between 1 June and 25 August 2021, with a dystocia prevalence of 3.3% (95% CI 2.9–3.7). Bodyweight data were available in 207 of 302 (68.5%) cases. The median bodyweight of dystocia cases was 12.5 kg (IQR 7.0–17.5, range 1.6–52.0). Breed or age data were not extracted. Of 791 puppies recorded as being born at Vets Now, 614 were recorded as alive at discharge (77.6%), giving an overall neonatal mortality of 22.4%. Table 2 displays results of the audit of 21 variables relating to clinical management of the 301 canine dystocia cases.

Between Audit Phases 1 and 2, significant ($p < 0.05$) increases were observed in the proportion of canine dystocia cases with recording of bodyweight, recorded usage of diagnostic imaging and recorded usage of ultrasonography. Significant ($p < 0.05$) decreases were observed in the median first quantity (iu/dog) and median first dose (iu/kg) of oxytocin. No significant changes were observed in recorded usage of radiography, recorded usage of oxytocin, recorded usage of calcium gluconate and recorded uptake of caesarean section (Table 2).

Between Audit Phases 2 and 3, significant ($p < 0.05$) increases were observed in the proportion of canine dystocia cases with recorded bodyweight, recorded usage of diagnostic imaging, recorded usage of ultrasonography, recorded measurement of fetal heart rates, recorded usage of oxytocin and calcium gluconate, recorded use of intravenous therapy during caesarean section, recorded post-ex utero timing of opioid product during caesarean section, recorded choice of full agonist as the opioid product during caesarean section, recorded usage of paracetamol during caesarean section, recorded usage of local anaesthesia during caesarean section and recorded usage of multimodal analgesia during caesarean section. Significant ($p < 0.05$) decreases were observed in the recorded usage of NSAIDs during caesarean section. No significant changes were observed in recorded usage of radiography, median first quantity (iu/dog) or median first dose (iu/kg) of oxytocin, recorded uptake of caesarean section and recorded usage of multiparameter monitoring during caesarean section (Table 2).

Between 2012 and 2021, significant ($p < 0.05$) increases were observed in the proportion of canine dystocia cases with recorded bodyweight, recorded usage of diagnostic imaging, recorded usage of ultrasonography and recorded usage of oxytocin and calcium gluconate. Significant ($p < 0.05$) decreases were observed in the median first quantity (iu/dog) and median first dose (iu/kg) of oxytocin. No significant changes were observed in recorded usage of

**TABLE 2** Comparison of 21 variables relating to the clinical management of canine dystocia cases seen at Vets Now between 1 September 2012 and 25 August 2021

| Observations on the clinical management of canine dystocia cases from the electronic patient records | Phase 1 (1 September 2012–28 February 2014), *n* (%) | Phase 2 (1 June 2018–31 May 2019), *n* (%) | *p*-Value | Phase 3 (1 June 2021–25 August 2021), *n* (%) | *p*-Value |
|---|---|---|---|---|---|
| Bodyweight recorded | 237 (33.8%) | 445 (59.1%) | <0.001* | 207 (68.5%) | 0.004* |
| Diagnostic imaging performed | 191 (27.3%) | 393 (52.2%) | <0.001* | 219 (72.5%) | <0.001* |
| Radiography performed | 113 (16.1%) | 111 (14.7%) | 0.467 | 36 (11.9%) | 0.232 |
| Ultrasonography performed | 92 (13.1%) | 337 (44.8%) | <0.001* | 197 (65.2%) | <0.001* |
| Fetal heart rate recorded | | 206 (27.3%) | | 147 (48.7%) | <0.001* |
| Oxytocin administered | 380 (54.2%) | 386 (51.3%) | 0.261 | 184 (60.1%) | 0.004* |
| Calcium gluconate administered | 82 (11.7%) | 67 (8.9%) | 0.768 | 51 (16.9%) | <0.001* |
| Oxytocin median first quantity (iu/dog) | 5 (IQR 3.0–8.0, range 0.2–50.0) | 4.0 (IQR 2.0–6.0, range 0.1–46.0) | <0.001* | 4.0 (IQR 2.0–8.0, range 0.16–23.0) | 0.183 |
| Oxytocin median first dose (iu/kg) | 0.36 (IQR 0.22–0.52, range 0.01–2.08) | 0.29 (IQR 0.17–0.46, range 0.001–2.0) | 0.008* | 0.25 (IQR 0.17–0.47, range 0.01–2.32) | 0.267 |
| Caesarean section performed | 341 (48.6%) | 350 (46.5%) | 0.409 | 136 (45.0%) | 0.670 |
| Caesarean sections with intravenous fluid therapy | | 303 (86.6%) | | 129 (94.9%) | 0.009* |
| Caesarean sections with multiparameter monitor findings recorded | | 269 (76.9%) | | 111 (81.6%) | 0.254 |
| Caesarean sections with opioid analgesia | | 318 (90.9%) | | 122 (89.7%) | 0.697 |
| Caesarean sections with timing of opioid recorded | | 271 (85.2%) | | 104 (85.2%) | 0.862 |
| Caesarean sections with pre-ex utero opioid recorded | | 44 (13.8%) | | 9 (7.4%) | 0.059 |
| Caesarean sections with post-ex utero opioid recorded | | 226 (71.1%) | | 95 (77.9%) | 0.049* |
| Caesarean sections with full agonist selected as opioid | | 276 (78.9%) | | 116 (85.3%) | 0.036* |
| Caesarean sections with NSAID analgesia | | 94 (26.9%) | | 18 (13.2%) | 0.001* |
| Caesarean sections with paracetamol analgesia | | 111 (31.7%) | | 107 (78.7%) | 0.001* |
| Caesarean sections with local anaesthesia | | 91 (26.0%) | | 51 (37.5%) | 0.012* |
| Caesarean sections with multimodal analgesia | | 193 (55.1%) | | 108 (79.4%) | 0.001* |

Abbreviation: IQR, interquartile range.
*Significant at $p < 0.05$.

radiography or recorded uptake of caesarean section (Table 2).

Engagement with updated digital learning platform dystocia resources by Vets Now staff between 7 May and 1 November 2021 was reported. From a population of 893 veterinary surgeons and veterinary nurses who had access to the learning platform, 9.0% ($n = 80$) viewed the caesarean postoperative guideline, 11.6% ($n$ = 104) viewed the dystocia clinical management checklist, 9.3% ($n = 83$) viewed the dystocia telephone triage checklist, 12.4% ($n$ = 111) viewed the dystocia webinar and 11.5% ($n$ = 103) viewed the Audit Phase 2 infographic. Unsolicited qualitative feedback about the experience of data collection from canine dystocia cases and attending the webinar was positive (Appendix 13).

## DISCUSSION

This paper describes the application of clinical audit within a QI process in a group of small animal primary-care emergency veterinary clinics (Figure 1). This discussion will explore how clinical audit can contribute to QI projects within veterinary practice, with suggestions gained from this experience on overcoming barriers during the planning phase of the clinical audit, facilitating uptake of clinical guidelines and encouraging QI activities in practice, using this audit of canine dystocia cases as a case study.

National clinical audit and QI projects are considered vital for good clinical governance and continual service improvement,[35] and have become integral to human healthcare over the past 15 years.[36] Small-scale


**FIGURE 2** Clinical audit in veterinary practice template

audits in small animal primary-care practice have reported on prescribing of fluoroquinolones in a small animal practice[37] and rabbit anaesthesia in a two-site small animal practice.[38] Anonymised veterinary clinical data collected by large electronic databases such as VetCompass[28,39] and vetAUDIT[40,41] can facilitate and support clinical audit.

During the planning phase of a clinical audit, important factors to consider include topic selection relative to available data collection tools, how to overcome common barriers such as limited existing published standards and how to encourage staff to engage with improving standards of care.[19] Large-scale data collection in primary-care practice often relies on the functionality of the internal practice management system, searching for chargeable related items, searchable protocols or using clinical coding to provide the relevant data.[42] Therefore, exploring the capabilities of the practice management system is an important part of the planning phase. Pilot audits are recommended as iterative exercises prior to implementation of an audit to identify areas for further consideration and mitigation.[19] Using the electronic patient record to extract data has limitations, but is an effective way to access cumulative clinical experience of a large group of practitioners, offering insight into current established practice.[43] In the current audit, the wide geographical spread and number of clinics, and the relatively large number of cases reviewed, likely reduced the possibility of data being skewed by individual clinicians or sites.

A recent systematic review on clinical audit in small animal veterinary practice cites the development of explicit criteria and the recurring cyclical nature of the audit process as key audit principles that are often unfulfilled; without these, most efforts towards 'clinical audit' are simply one-off surveys of practice.[19] In the current audit, there was a paucity of previous high-quality published evidence on managing dystocia in primary-care practice. Interpretation of available pathways of care for dystocia cases within Vets Now were examined and combined with current peer-reviewed evidence[44–48] to produce resources to support improved dystocia case management. Explicit audit criteria were defined for clinical management of dystocia cases, including recommended drug dosages and identifying drugs or clinical practices no longer recommended for these patients.

Clinical guidelines offer recommendations for optimising patient care, informed by a systematic review of evidence and an assessment of benefits and harms of alternative care options.[49] Guidelines can have multiple purposes, including to improve effectiveness and quality of care, to decrease variations in clinical practice and to decrease errors and adverse events.[50] In human medicine, key sources of evidence underpinning clinical practice guidelines include the Cochrane Library[51] and National Institute for Clinical Excellence[52] databases. High-quality evidence assists clinicians, patients, researchers and policymakers in making informed decisions and recommendations for care.[53] In veterinary medicine, similar evidential hubs, such as RCVS Knowledge,[54] are under development. In human medicine, clinical practice guidelines have been reported to be somewhat effective in supporting changes in process and outcomes in practice, although the majority of clinical practice guidelines are not effectively implemented.[55,56] Reasons for resistance to guideline adherence are multifaceted.[57–59] Guideline adherence can improve via raising awareness, familiarity and securing agreement with content.[60] Education requiring active participation is more effective in changing clinical activity than simply providing information via documentation or didactic continuing professional development sessions.[61] Examples of interactive education include discussions of evidence, local consensus, peer feedback and making personal and group learning plans. Collective involvement and endorsement by stakeholders are essential for effective change.[62,63] The current audit sought collective participant involvement and endorsement by establishing internal auditors, an internal working party and interactive learning methods for dissemination of information within the organisation. Staff involvement is essential to combat audit failure.[21,35,63]

Within the veterinary sector, a recent report[1] revealed that over half of veterinary professionals surveyed reported no engagement with QI activities within the previous year. Creating protected time for QI activities is essential to overcome competing clinical priorities.[2] Additionally, it has been reported that change in practice is positively influenced when the professional and organisational culture supports QI.[61] The structure of the current audit ensured adequate time and resources were available for the working group and other key stakeholders, in an environment supporting a learning culture.[64,65]

The results of the current audit suggest that dystocia case management broadly improved through each audit phase, including a significant increase in the use and recording of neonatal monitoring via fetal heart rate assessment during ultrasonography. This is encouraging, as diagnostic imaging is reported as a critical tool for successful management of canine dystocia.[66] Another area of improvement identified was better prescribing practice. Improved pharmacovigilance and safer prescribing practice were noted progressively in each audit phase. However, data obtained in this audit on puppy mortality were difficult to interpret due to inconsistency and varying levels of detail recorded on the electronic patient record. The specific wording used on the audit record form was not explicit on whether it referred to mortality of puppies born at Vets Now only or whether it also included puppies born prior to presentation. Therefore, a learning point here is of the value of precise case definitions for all data extracted. Neonatal mortality is an area identified for focus in future audit cycles, when more reliable data can support greater confidence in the conclusions drawn.[67,68] The cycles of the current clinical audit have identified positive changes in practice and also identified important areas for future work, which are key elements of the iterative process of clinical audit.

## Strengths and limitations

Vets Now is a dedicated small animal primary-care emergency service for partnered practices throughout the UK, sharing detailed clinical records with these practices daily, ensuring case continuity and fulfilling the professional obligation to record comprehensive contemporaneous clinical notes.[5]

Overall, the clinical notes provided sufficient information for a detailed audit.[42] Well-defined search criteria were used to search the electronic patient records for relevant cases.[69] A data engineer carried out the searches in Audit Phases 2 and 3 in collaboration with Lucy Leicester, the lead clinical auditor, to minimise error. The use of observational data over a prolonged period reduces the Hawthorne effect,[7,19] whereby awareness of being observed leads to behaviour-modifying effects, regardless of the context of investigation.[70] Emergency departments, compared with general practice, are inherently higher risk settings for error that can result in patient harm.[71] The current audit took place in such a setting, so negative impacts on patient safety were avoided by using an observational design that did not add to the cognitive load and task list of the veterinary teams. The audit examined the clinical management of canine dystocia cases seen in a dedicated emergency setting. Aspects of case presentation and management may vary from those seen in non-emergency primary-care small animal practice. Colleagues may wish to carry out similar audits in their own practices to compare results.

This current audit demonstrates the feasibility of large-scale veterinary clinical audit and suggests that the application of the clinical audit process promotes learning within the veterinary team and improved clinical outcomes. Clinical governance is a compulsory professional obligation for UK-based veterinary surgeons and veterinary nurses,[4] and the current audit could be used as a template by other veterinary teams planning clinical audits in practice. It may also encourage other QI projects.[41] The results highlight that careful planning and adequate resources are critical for success. Involvement of the wider veterinary team provides additional impetus for guideline adherence. The current audit also highlights clinical audit as an iterative process, and although it may generate more questions than answers, it offers a useful opportunity to engage staff members in the QI process at a local level and beyond.

This audit charts the clinical trajectory and management of emergency dystocia cases. The methods and results can serve as a benchmarking tool to evaluate management of canine dystocia for other institutions or within primary-care veterinary practice. The proposed template (Figure 2) may serve as a helpful tool for others aiming to plan, implement, analyse and review clinical audits in other areas within primary veterinary practice. Finally, this project demonstrates that effective clinical audit in a multisite small animal practice is feasible, especially when supported by more experienced individuals or in collaboration with academic institutions. Additionally, it is clear that primary research can inform clinical audit, and likewise clinical audit can support future research.

## AUTHOR CONTRIBUTIONS

Aoife Reid, Dan G. O'Neill, Lucy Leicester, Sophie Gilbert and Racheal Marshall were responsible for the conception and design. Aoife Reid, Dan G. O'Neill, Lucy Leicester, Sophie Gilbert and Racheal Marshall were responsible for the acquisition and extraction of data. Dan G. O'Neill and Lucy Leicester carried out the analysis. Aoife Reid, Dan G. O'Neill, Lucy Leicester, Sophie Gilbert and Racheal Marshall were mainly responsible for drafting the manuscript. Aoife Reid, Dan G. O'Neill, Lucy Leicester, Sophie Gilbert and Racheal Marshall were involved in interpreting the results, revising the manuscript and gave final approval of the version to be published. Aoife Reid, Dan G. O'Neill, Lucy Leicester, Sophie Gilbert and Racheal Marshall agree to be accountable for all aspects of the accuracy and integrity of the work.

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## CONFLICT OF INTEREST

Lucy Leicester, Aoife Reid, Sophie Gilbert and Racheal Marshall are employees of Vets Now.

## DATA AVAILABILITY STATEMENT

The data that support the findings of this study are available from the corresponding author upon reasonable request.

## ETHICS STATEMENT

Ethics approval was sought from and granted by the RVC Social Sciences Research Ethical Review Board (reference number: URN SR2021-0075).

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## SUPPORTING INFORMATION

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


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