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ORIGINAL RESEARCH

Assessing primary care veterinarians' use of and confidence in performing point-of-care ultrasound

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Abstract

Background: Point-of-care ultrasound (POCUS) is gaining popularity in the veterinary field, but there is little information on operator confidence.

Methods: A survey was distributed to primary care veterinarians (PCVs) via social media between May and July 2020. Details of participants' training in and use of POCUS were recorded. Participants' confidence in using thoracic and abdominal POCUS was also assessed using a five-point Likert scale.

Results: Two hundred and one PCVs used POCUS, of which 32% reported using a non-standardised protocol. Fifty percent of PCVs were self-taught and 17.4% had attended a specific practical course. The median confidence score was 4 out of 5 (interquartile range [IQR] 2–5) for identifying abdominal abnormalities, irrespective of the training method. The median confidence score for thoracic abnormalities was 3 out of 5 (IQR 1–4) for those taught by a colleague or who were self-taught using journal articles or videos.

Limitations: The survey-based nature of the study relies on self-reporting and is therefore liable to recall bias.

Conclusions: PCVs' confidence in using POCUS is lacking, particularly with thoracic POCUS. Standardised practical training for PCVs, particularly in thoracic POCUS, would be beneficial. Future studies should explore how best to deliver this training.

INTRODUCTION

Point-of-care ultrasound (POCUS) is a diagnostic tool commonly performed at the bedside that can be used to assist with rapid decision making or therapeutic interventions. As POCUS is commonly performed by physicians who would not traditionally have been trained in diagnostic imaging (DI), the protocols that have been developed in the human field are system focused and aim to answer binary questions. The use of POCUS is a relatively new concept in veterinary medicine; however, it has been found to be useful in the emergency and critical care setting, and various veterinary-specific protocols have been described.[1–3] These protocols have been useful in helping diagnosis of life-threatening conditions in animals presenting as an emergency[4–6] and monitoring of critical patients.[7–9] Ultrasound has also been demonstrated to be more sensitive in diagnosing certain pulmonary diseases compared to radiographs[6,10,11] and has the advantage that it can be performed in awake, unstable patients.

In the human field, POCUS training is a mandatory component of the Royal College of Emergency Medicine curriculum,[12] which has allowed for standardisation of the POCUS technique.[2] With training, physicians' POCUS knowledge, confidence and technical skill have been shown to be significantly improved.[13] Furthermore, structured practical training has been shown to be superior to apprenticeship and didactic training.[14] In veterinary medicine, there is no formal requirement for POCUS training and the availability of practical training is low.

The primary aims of this study were to understand the utility of POCUS among small animal primary care veterinarians (PCVs) and to assess their level of confidence in performing POCUS. The secondary aims were to determine what level of POCUS training individuals receive and whether this affected their confidence in the technique, as well as to explore the preferred methods for additional training. Our hypothesis was that PCVs with formal, practical training would be more confident in using POCUS.

MATERIALS AND METHODS

The investigation was approved by the Social Sciences Research Ethical Review Board of the Royal Veterinary College (reference SR2020-0163, approved 27 May 2020). An anonymous survey was created on an online survey programme (Supporting Information) and was distributed to small animal veterinarians via veterinary-specific social media groups between May and July 2020. Participation in the survey was entirely voluntary and respondents were allowed to withdraw at any time. Respondents were not required to answer every question, and the use of free-text answers was limited. Free-text answers were reviewed and either combined with the primary dataset or assigned to a new category if there were multiples of the same answer.

Respondents who listed themselves as working in general practice with or without out-of-hours (OOH) or working in emergency/OOH only were considered PCVs for this investigation, and their responses were assessed as the primary focus. Respondents listed as undertaking an internship, residency or working as a specialist were not analysed further.

Respondents were asked for demographic information, such as year of graduation and details of any postgraduate qualification they had obtained. Respondents were also asked to specify any DI continuing professional development (CPD) they had completed in the last 5 years, categorised into: online webinar, online course, DI lecture in either a general conference, DI-specific conference or emergency and critical care-specific conference, practical course or other, with the option to provide a free-text answer.

The remaining questions were specific to POCUS, including if and how often respondents used POCUS and which of the published protocols the respondents were familiar with. The protocols included were as follows: abdominal- and thoracic-focused assessment with sonography for trauma, triage and tracking (AFAST/TFAST), airway, breathing, circulation, disability and exposure (ABCDE) and veterinary bedside lung ultrasound examination (Vet-BLUE).[3,7,15] Respondents were asked whether they used these protocols in their practice, or their own, non-standardised, protocol. Respondents were requested to specify how they received training in their technique with the following options: self-taught using journal articles, self-taught using online videos, self-taught by other means, taught by an experienced colleague, specific practical training course or other, such as undergraduate training, postgraduate training or POCUS-specific hands-off training.

Respondents were asked to assess their confidence in using POCUS, first by asking if they were confident in identifying various structures or signs within the abdomen and thorax and then by grading their confidence in identifying abdominal, cardiac and thoracic abnormalities using a five-point Likert scale (1: not at all confident, 2: not very confident, 3: neither, 4: fairly confident, 5: very confident). A list of the signs respondents were asked to identify, including definitions where appropriate, is provided in Table 1. Respondents were also asked how they charge for POCUS, what limits their use of POCUS and how they would prefer to receive further training, with the choice of a lecture course, online course, practical with phantoms or practical with live animals. Respondents could select multiple answers for the further training question.

Data were compiled using commercial software (Microsoft Excel, version 16). Descriptive statistical analysis was used to summarise the responses, and percentages were calculated from frequency data. A Shapiro–Wilk test was used to assess normality. All data were non-parametric and were thus reported as the median and interquartile range (IQR).

RESULTS

Two hundred and fifty people responded to the survey and 192 completed every question (completion rate 76.8%). The results from both complete and incomplete surveys were analysed. Eighty-four percent (211/250) of respondents worked in general practice (PCVs), 8% (20/250) were undertaking an internship, 5.6% (24/250) worked as a specialist and 2% (5/250) were in residency training. Further analysis was performed on the 211 veterinarians working in a primary care setting.

Demographics

The median graduation year of PCVs was 2013 (IQR 2008–2016). Most PCVs worked in general practice with no OOH (84/211, 39.8%), followed by general practice with OOH (76/211, 36.0%) and emergency/OOH only (51/211, 24.1%). Eighty-three PCVs had been awarded a postgraduate qualification (83/211, 39.3%), as outlined in Table 2. Six respondents had a postgraduate qualification specific to DI (6/83, 7.2%).

POCUS protocol awareness and utilisation

Two hundred and one of the 211 (95.3%) PCVs used POCUS in some form, referred to now as PCV POCUS users. The other 10 PCVs (4.7%) did not use any POCUS modality at all. With regard to frequency of use, most used POCUS on a weekly basis (84/201, 41.8%), followed by daily (54/201, 26.9%), monthly (35/201, 17.4%) and rarely (28/201, 13.9%).

Most of the PCV POCUS users were familiar with the AFAST and TFAST protocols (197/201, 98.0% and 186/201, 92.5%, respectively). Lesser-known protocols included Vet-BLUE (55/201, 27.4%) and ABCDE (11/201, 5.5%). Of the 201 PCV POCUS users, two were aware of another protocol not listed (1.0%; pleural space and lung ultrasound), and three had not heard of any protocol (1.5%). When asked to specify what protocol they utilised, 172 (85.6%) used AFAST, 149 (74.1%) used TFAST, 19 (9.5%) used Vet-BLUE and six (3%) used ABCDE. None of the respondents used a

TABLE 1 List of definitions of point-of-care ultrasound findings that respondents were asked if they were confident in identifying

A lines	Horizontal lines produced by reverberation artefact originating at the parietal pleura. Normal finding in aerated lung.
B lines	Echogenic vertical artefacts originating from the pleural line to the distal image. They are considered to be representative of extravascular lung water and used for semi-quantitative assessment.
E lines	Vertical echogenic lines originating in the subcutaneous space, representative of subcutaneous emphysema.
Z lines	Short vertical lines originating from the pleural line. Normal finding in aerated lung. Differ from B lines as they do not obliterate A lines and do not move synchronously with respiration.
Glide sign	Sliding movement seen at the pleural line in time with respiration. Indicates the parietal and visceral pleura are in contact and not separated by pathology (e.g., pneumothorax).
Lung pulse	Conduction of cardiac beats to pleura, seen using M-mode. Absence of lung pulse indicates pleural pathology (e.g., pneumothorax).
Curtain sign	Moving vertical line generated by the dynamic motion of lung over the abdominal organs in the caudal thorax. Normal finding in aerated lung, can be altered or absent in certain pathologies (e.g., pleural effusion, diaphragmatic hernia).
Step sign	Deviation of continuity in pleural line away from the probe. If present with no other subpleural signs, can represent trauma such as rib fracture.
Shred sign	Irregular, jagged pleural line, found adjacent to consolidated lung in the periphery.
Subpleural nodule	Oval-shaped notch in the pleural line.
Tissue sign	Consolidation of the lung, appearance similar to soft tissue/liver.

TABLE 2 Breakdown of primary care veterinarian postgraduate qualifications ($n = 211$)

Cert AVP	18
Postgraduate certificate/diploma	31
Master	23
PhD	1
RCVS certificate	9
European (EVBS) diploma	3
Member ANZCVSc	9
Other	4

Note: Some respondents held multiple postgraduate qualifications.
Abbreviations: ANZCVSc, Australian and New Zealand College of Veterinary Scientists; Cert AVP, Certificate in Advanced Veterinary Practice; EVBS, European Board of Veterinary Specialists; PhD, Doctor of Philosophy; RCVS, Royal College of Veterinary Surgeons.

non-listed protocol. Sixty-five of the 201 PCV POCUS users used their own, non-standardised, protocol (32.3%).

The majority of PCV POCUS users were self-taught (101/201, 50.2%), with 33 (32.7%) using journal articles, 11 (10.9%) using online videos as an aid and 57 (56.4%) being self-taught by other means. Of the 201 users, 48 (23.9%) received their POCUS training from a colleague and 35 (17.4%) had attended a specific practical course. Fourteen (7.0%) PCV POCUS users cited that they used other resources. These resources were undergraduate teaching (8/201, 3.9%), POCUS-specific lecture (3/201, 1.5%), POCUS-specific webinar (2/201, 1.0%) and internship training (1/201, 0.5%). Three PCV POCUS users (1.5%) reported that they had received no training.

Confidence in technique

In terms of structures, PCV POCUS users were most confident in detecting free peritoneal fluid, the urinary bladder and the liver on abdominal POCUS (A-POCUS) and least confident in detecting the ureters and the ovaries (Figure 1a). They were most confident in identifying pleural and pericardial fluid on thoracic POCUS (T-POCUS) and least confident in identifying the lung pulse and subpleural signs, such as E lines and Z lines (Figure 1b).

In terms of pathologies, PCVs were most confident in diagnosing the presence of free fluid and pyometra on A-POCUS and least confident in detecting pancreatitis, ureteral obstruction and gastrointestinal foreign body (Table 3). PCVs were most confident in diagnosing pericardial and pleural effusion and cardiac tamponade on T-POCUS and least confident in diagnosing pulmonary hypertension, bronchial disease and bronchopneumonia (Table 4). Confidence in diagnosing thoracic pathologies was lower overall.

Prior training and training method did not affect the PCV POCUS users' median confidence score in the identification of abdominal abnormalities, with all methods scoring 4 out of 5 (IQR 2–5). The median confidence score for thoracic abnormalities was 3 out of 5 (IQR 1–4) for those who had been taught by an experienced colleague or were self-taught using journal articles or videos. The remaining training methods scored 2 out of 5 (IQR 1–4) (Table 5). Having either a postgraduate qualification or undertaking any practical DI CPD did not result in a higher median confidence score in either abdominal or thoracic POCUS compared to PCV POCUS users who had neither (Table 6).

Charging, limitations and further training

Of the 201 PCV POCUS users, 181 (90.0%) stated that they charged for POCUS, whereas 20 (10.0%) did not. Of the 181 users that charged, 114 (63.0%) charged for each scan individually and 60 (31.4%) charged once to perform multiple scans per day. Seven respondents who reported charging for POCUS did not specify further.

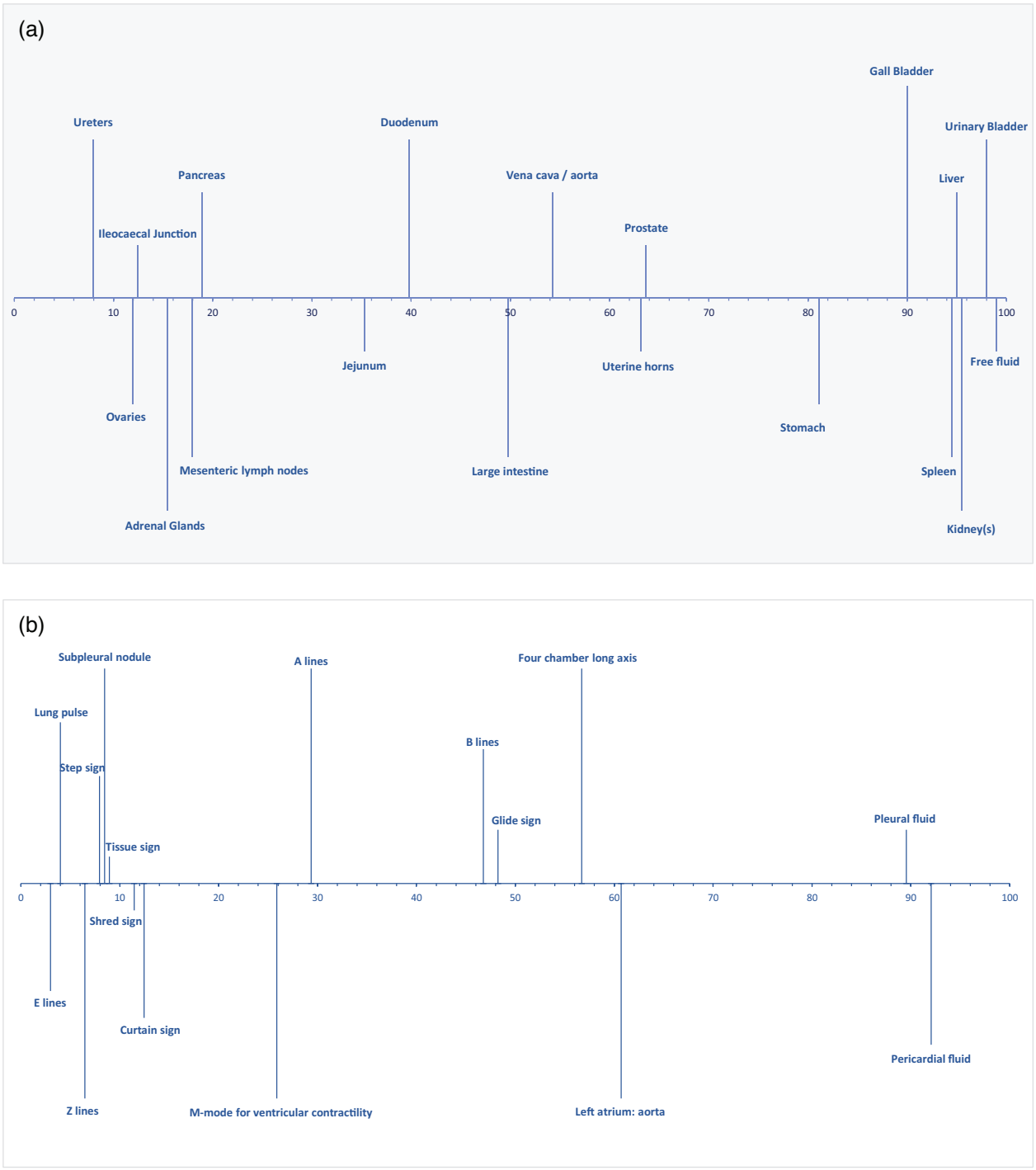

FIGURE 1 Scales showing the percentage of primary care veterinarian point-of-care ultrasound users ($n = 200$) confident in identifying (a) abdominal structures and (b) thoracic structures and signs

Out of all the PCVs, including those who were not POCUS users, the most common reason cited that limited use was lack of confidence in performing the procedure (89/211, 42.2%), followed by the cost incurred to the client (62/211, 29.4%). Of the 211 PCVs, 15 (7%) preferred to use radiographs, 11 (5.2%) were prohibited by the cost of the ultrasound machine and five (2.4%) reported that ultrasound was not readily available to them. Of the other described limitations, out of 211 PCVs, seven (3.3%) did not feel there was a benefit to using POCUS, five (2.4%) only used it if they felt there was a direct indication, three (1.4%) reported that they did not have time to use it and one respondent felt limited by the need to use clippers.

Regarding the preference for further training, out of 210 PCVs, 189 (90%) chose practical training with live animals, 73 (34.8%) chose practical training with models, 56 (26.7%) chose an online course and 23 (11.0%) chose a lecture course.

DISCUSSION

Over 95% of the veterinarians who participated in this survey used POCUS to some extent in practice. This

TABLE 3 The level of confidence of primary care veterinarian point-of-care ultrasound users ($n = 200$), expressed as a percentage, for diagnosing common abdominal pathologies

	Peritoneal fluid	Splenic mass	Hepatic mass	Pancreatitis	Gall bladder mucocele	Ureteral obstruction	Gastrointestinal foreign body	Bladder stones	Pyometra	Prostatitis	Intussus-ception	Ileus (non-specific)
1. Not at all confident	1.0%	1.4%	1.4%	32.5%	10.0%	29.7%	8.6%	1.4%	1.4%	10.1%	8.1%	12.0%
2. Not very confident	1.9%	5.7%	6.2%	**33.5%**	12.4%	**33.0%**	**32.5%**	1.4%	1.0%	21.6%	23.0%	22.5%
3. Neither	1.9%	6.2%	8.6%	11.5%	10.5%	16.3%	26.8%	5.7%	2.9%	19.2%	23.4%	17.2%
4. Fairly confident	38.8%	**46.9%**	**63.2%**	18.7%	**45.5%**	17.2%	28.7%	**46.9%**	31.6%	**35.1%**	**33.0%**	**37.3%**
5. Very confident	**56.5%**	39.7%	20.6%	3.8%	21.5%	3.8%	3.3%	44.5%	**63.2%**	13.9%	12.4%	11.0%

Note: The most popular score for each pathology is highlighted in bold.

TABLE 4 The level of confidence of primary care veterinarian point-of-care ultrasound users ($n = 199$), expressed as a percentage, for diagnosing common cardiothoracic pathologies

	Congestive heart failure	Pericardial effusion	Cardiac tamponade	Cardiac mass	Pulmonary hypertension	Pulmonary contusions	Aspiration pneumonia	Broncho-pneumonia	Bronchial disease	Pulmonary neoplasia	Thoracic mass	Diaphra-gmatic rupture	Pleural effusion	Pneumo-thorax
1. Not at all confident	18.8%	1.9%	8.6%	14.8%	**53.1%**	**40.2%**	**45.0%**	**49.8%**	**55.8%**	**36.8%**	23.1%	16.3%	5.7%	15.8%
2. Not very confident	23.6%	5.7%	13.9%	29.7%	30.6%	30.1%	27.3%	28.2%	27.9%	30.1%	**31.7%**	26.0%	5.7%	22.5%
3. Neither	16.3%	5.3%	14.4%	**31.1%**	7.7%	14.8%	15.3%	15.8%	13.0%	23.0%	26.9%	22.1%	7.7%	19.1%
4. Fairly confident	**29.3%**	38.8%	**35.4%**	21.1%	7.7%	11.0%	10.5%	5.7%	3.4%	7.7%	15.9%	**30.8%**	**40.7%**	**33.5%**
5. Very confident	12.0%	**48.3%**	27.8%	3.3%	1.0%	3.8%	1.9%	0.5%	0.0%	2.4%	2.4%	4.8%	40.2%	9.1%

Note: The most popular score for each pathology is highlighted in bold.

TABLE 5 Median (interquartile range) confidence score out of 5 for identifying abdominal or cardiothoracic abnormalities/structures for primary care veterinarian point-of-care ultrasound users across different types of training

	Experienced colleague	Self-taught: other means	Self-taught: journals	Self-taught: video	Practical training course	Other
Abdomen	4 (3–5)	4 (2–5)	4 (3–5)	4 (3–5)	4 (3–5)	4 (3–5)
Thorax	3 (1–4)	2 (1–4)	3 (1–4)	3 (1–4)	2 (1–4)	2 (1–4)

TABLE 6 Median (interquartile range) confidence score out of 5 for identifying abdominal or cardiothoracic abnormalities/structures for primary care veterinarian point-of-care ultrasound users with and without postgraduate (PG) qualifications or practical training

	PG qualification	No PG qualification	Practical training course	No practical training course
Abdomen	4 (3–5)	4 (2–4)	4 (2–4)	4 (2–4)
Thorax	2 (1–4)	2 (1–4)	2 (1–4)	2 (1–4)

is higher than previously reported, with usage rates ranging between 53% and 88%.[16,17] This discrepancy may be due to geographical differences, as we did not restrict responses to one area, or may be due to a younger population responding to our survey. In both of these previous studies, the lack of availability of ultrasound was the most commonly cited reason for lack of use, which was not the case for our population.

The biggest barrier to using POCUS among our respondents was confidence; lack of confidence and training were also found to be some of the greatest limitations in similar studies.[17,18] In our population, prior training (including practical training) did not affect overall confidence. However, there was an overwhelming preference for practical training using live animals among respondents. Studies in both the medical and veterinary fields have demonstrated the benefit of hands-on training in improving confidence and diagnostic capability.[13,19–21] The low number of respondents who had undertaken additional training is likely to have affected our ability to detect an effect of training on confidence. Given the previously reported beneficial effects of training on POCUS proficiency and confidence and the demand for training identified in this study, there should be a focus on increasing the availability of training. However, provision of hands-on training with live animals would come with many logistical and practical challenges. Further studies should explore how best to deliver training that can be implemented on a large scale.

The most common protocol used by our study population was AFAST, followed by TFAST. Compared to another study,[17] slightly more of our respondents used TFAST, but similar to our results, the uptake of T-POCUS was lower than that of A-POCUS. We asked our respondents to discuss their use of other protocols and discovered that 32.3% of the PCV POCUS users reported that they used their own POCUS protocol. Regardless of the chosen protocol, we did not assess for compliance. By performing incomplete or non-protocolised POCUS examinations, veterinarians may be over- or underdiagnosing pathologies or not fully utilising the diagnostic potential of POCUS. However, it may be neither practical nor sensible to perform complete POCUs examinations for every emergency case at the time of presentation. It also stands that the use of non-standardised protocols limits the interpretation of serial exam findings performed by different members of staff. The inclusion of POCUS training as a compulsory element of emergency medicine curricula in the human field has prompted the development of standardised training,[2] and training increases confidence and proficiency.[13,22] Education on the benefits of using standardised POCUS approaches, as well as the diagnostic limitations of this modality, may be useful.

The confidence of PCV POCUS users in A-POCUS was overall greater than that in T-POCUS, with more of our respondents feeling confident in the identification of abdominal structures than thoracic structures. Confidence scores were also higher overall for abdominal pathologies, with the majority of respondents answering 'fairly confident' or 'very confident' for nine out of the 12 options available. Identification of the highest scoring pathology, peritoneal free fluid, is one of the earliest described uses of veterinary POCUS,[23] and studies have shown potential for its use for semi-quantitative assessment of the amount of fluid present.[24,25] Other high-scoring pathologies, such as pyometra and splenic mass, have historically been best diagnosed using ultrasound in a primary care setting, and the target-organ approach adopted in A-POCUS protocols would allow for quick visualisation of these organs. One of the lowest-scoring pathologies, pancreatitis, is more technically difficult to identify and ultrasonographic changes do not necessarily correlate to disease severity.[26,27] The other two pathologies veterinarians were less confident in diagnosing were ureteral obstruction and gastrointestinal foreign body; precise diagnosis of both also comes with a higher skill cap, with a combination of modalities often being used to diagnose the latter.

When looking at cardiovascular POCUS (CV-POCUS) in insolation, our PCV POCUS users were more confident in obtaining the left atrium to aortic ratio in comparison to a previous study.[18] This population consisted entirely of emergency PCVs based at a single centre, where lack of training in CV-POCUS was one of the main reasons for low confidence. Congestive heart failure was one of the thoracic pathologies that our respondents felt most confident in identifying, with 29.3% saying they felt fairly confident in

diagnosing it. One of the earlier applications of POCUS in non-traumatised companion animals was the detection of cardiogenic pulmonary oedema, based on the number and distribution of B lines.[28] Less than half of our PCV POCUS users were confident in identifying B lines, which was disproportionate to the number that would confidently diagnose congestive heart failure. Previous studies disagree on the diagnostic benefit of CV-POCUS in differentiating cardiac and non-cardiac respiratory distress compared to history and clinical examination alone.[29,30] An explanation for this discrepancy in our results could be that the veterinarians surveyed are more reliant on those other factors, as opposed to POCUS.

Pulmonary hypertension was one of the lowest-scoring cardiovascular pathologies. One study demonstrated that POCUS was not sensitive in screening for pulmonary hypertension,[31] whereas another found that, with a more complete protocol and training, diagnosis of pulmonary hypertension was improved.[32] It follows that most respondents to our survey lack confidence in using POCUS for diagnosis. No standardised protocol for CV-POCUS has been described, and most assessments remain subjective. Confidence in obtaining cardiac views on POCUS could be improved by devising a specific CV-POCUS protocol to improve confidence in turn.

Our data show that some of the thoracic conditions veterinarians feel least confident in diagnosing include pulmonary contusions, aspiration pneumonia, bronchopneumonia and pulmonary neoplasia. As previously mentioned, almost half of our respondents could confidently identify B lines. The distribution of B lines on lung ultrasonography can help diagnose conditions other than cardiogenic pulmonary oedema, including aspiration pneumonitis/pneumonia or pulmonary contusions,[11,33,34] but identification of other signs, such as a shred or tissue sign, is more technically difficult. As these signs were also not reported in companion animals until more recently, compared to B lines, it is possible that this delay results in lower confidence, either through a lack of resources available for veterinarians to use to guide their learning or by affecting the teaching or training that is available to veterinarians. The association between B-line distribution, subpleural visualisation and underlying pathology is also well described in human medicine,[35] but there is limited veterinary literature on the use of ultrasound for diagnosis of perihilar conditions or neoplasia.[36]

Surprisingly, less than 50% of respondents felt confident in diagnosing pulmonary contusions using POCUS. The diagnosis of pulmonary contusions (presence of B lines in an animal with a history of trauma) was one of the earlier uses reported for TFAST.[7] A study comparing POCUS and thoracic radiographs showed that pulmonary contusions were more easily identified on ultrasound than on radiographs compared to computed tomography.[11] Making the diagnosis of pulmonary contusions consists of pairing ultrasound findings with the clinical history, so our findings may show that education on the interpretation of POCUS findings is needed to improve confidence, as opposed to purely focusing on technique. However, when looking at previously published studies on T-POCUS, the area in which PCVs have more confidence making a diagnosis with B lines (congestive heart failure) is more well established in the literature. The lower confidence in diagnosis of pulmonary contusions or aspiration pneumopathy could be because they are more novel descriptions and less commonly encountered.

Our results show that confidence in performing A-POCUS was consistently high compared to T-POCUS. An explanation for this difference could be that veterinarians are more likely to be competent in performing a full abdominal ultrasound examination, as this would have been incorporated into their undergraduate training as well as their development as a veterinarian. Thoracic ultrasound is a more novel technique and is generally described as a part of POCUS, and most protocols have been published in the last 5–10 years. Although T-POCUS is becoming more widely used, the teaching of POCUS within the undergraduate curriculum is likely variable between institutions.

One of the main limitations of our study is the potential for respondents to provide inaccurate or biased responses, owing to the survey-based nature of our data collection. There is the potential for respondents to either over- or underestimate their ability. The use of social media to obtain responses potentially selects for a younger population of veterinarians, who are more likely to have been exposed to newer concepts such as POCUS during their undergraduate training. In spite of this, our respondents were still found to be lacking confidence in POCUS. We were unable to retrospectively discern current country of practice from our data to determine the representativeness of our results. Although the primary target for responses was UK-practising veterinarians, the findings are likely applicable to a wider population of veterinarians given the universally novel nature of POCUS. Our findings should, however, be considered with respect to the small sample size presented here. It is also important to note that confidence is not a proxy for competence; future studies could focus on a more objective measure of proficiency using POCUS, such as assessing image acquisition and image interpretation, to better determine competency.

In conclusion, while POCUS use is widespread, low confidence in the technique, particularly thoracic POCUS, remains the major limitation for veterinarians to perform POCUS. Further training is required to educate veterinarians on the benefits of standardised protocols and to improve veterinarians' confidence and proficiency in performing POCUS. Future studies should focus on how best to provide this training to improve confidence and competence in POCUS.

AUTHOR CONTRIBUTIONS

All authors contributed to the study design and concept. Data collection and analysis were performed by Charlotte McDonald. Charlotte McDonald drafted the

manuscript. Laura Cole and Dominic Barfield revised the article, and all authors approved the submitted version.

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CONFLICT OF INTEREST STATEMENT

The authors declare they have no conflicts of interest.

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DATA AVAILABILITY STATEMENT

The data that support the findings of this study are available on request from the corresponding author. The data are not publicly available due to privacy or ethical restrictions.

ETHICS STATEMENT

The investigation was approved by the Social Sciences Research Ethical Review Board of the Royal Veterinary College (reference SR2020-0163, approved 27 May 2020).

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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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