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THE VALUE AND LIMITATIONS OF ECHOCARDIOGRAPHY IN SMALL ANIMAL PRACTICE

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INTRODUCTION

Twenty years ago, ultrasonography was rarely used in small animal practice. At that time it was only available in some tertiary referral centres and the equipment was well below the currently accepted standards in terms of image resolution and processor power. Today, echocardiography is performed as the 'in clinic' diagnostic gold standard for most cardiac conditions. Lower equipment costs, increased under-graduate and post-graduate training opportunities, and improved image quality have made this imaging modality accessible to many small animal practitioners.

It would be reasonable to speculate that the impressive performance of echocardiography has led to some erosion of our clinical examination skills and has adversely affected our decision-making regarding the use of other tests, such as thoracic radiography. To counter this trend, it is important to utilise echocardiography as a component of the overall cardiac assessment, rather than as a single test replacing a more balanced diagnostic plan. If used correctly, it has the potential to improve our clinical skills and our interpretation of thoracic radiography.

It is imperative than all veterinarians and technicians appreciate that echocardiography performed in the absence of a sound understanding of the principles of cardiology is of limited use. When the clinician's imaging skills are not supported by a similar level of cardiology knowledge, there is the potential for inaccurate diagnoses and the subsequent use of expensive and potentially harmful therapy.

USES

Echocardiographic standards

It is difficult to discuss the utility of echocardiography without addressing the influence of differing levels of operator skill and experience. There are no fast tracks to gaining experience. Cardiology residents typically gain competence after approximately 500 cases, under the direct supervision of a cardiologist, on high-end equipment with intensive training in the areas of cardiac anatomy, haemodynamics and pathophysiology.

Novice*:* for those just starting out on this steep learning curve, obtaining accurate 2-D views and repeatable M-mode measurements are the major challenge. At this level, the use of Doppler assessment is more likely to be a hindrance than a help with the diagnosis. The most common conditions that can be accurately described at this stage include pericardial effusion, overt dilated cardiomyopathy (DCM), mitral regurgitation and advanced feline hypertrophic cardiomyopathy. Given that these conditions make up the majority of presentations, the novice sonographer with a good understanding of the principles of cardiology can improve patient care within the practice.

***Intermediate**:* sonographers in this category will typically have experienced supervision via post-graduate course work and/or from a colleague trained in this area. The quality of the ultrasound system and the clinician's cardiology skills are critical at this stage. Any short-comings such as poor quality Doppler or inadequate probe specifications (eg footprint size and beam penetration/resolution) will limit what can be achieved.

In addition to the conditions already described, the intermediate sonographer has the potential to diagnose congenital defects such as pulmonic stenosis, ventricular septal defects, AV valve dysplasia, patent ductus arteriosus and developmental defects such as sub-aortic stenosis. However, this will potentially bring the clinician in contact with breeders/pet shops/colleagues/specialists and some legally awkward issues that come with this area *(see Limitations for further discussion).*

Conditions such as pulmonary hypertension, heartworm disease, heart base tumours, aortic insufficiency and advanced feline restrictive cardiomyopathy may also be within the capabilities of the intermediate sonographer. It would be reasonable practice to offer further consultation with a specialist for many of the conditions listed above.

***Advanced**:* echocardiography at this level is most commonly performed by cardiologists, radiologists and internal medicine specialists. Some radiologists and internists are skilled in this area, while others prefer to focus on abdominal imaging.

Ultrasound systems for this category of scanning require excellent 2-D resolution, high frame rates and good quality Doppler. Ideally these systems would carry a range of additional software to enable cardiac chamber area/volume calculations, tissue Doppler imaging, image enhancement options and potentially strain rate assessment in the future.

In addition to the cardiac defects mentioned above, complex or subtle conditions such as right-to-left shunts, atrial septal defects, AV valve stenoses, coronary artery defects, occult DCM, cor triatriatum, feline heartworm disease, persistent left cranial vena cava, canine hypertrophic cardiomyopathy and feline diastolic dysfunction may be identified.

LIMITATIONS AND PITFALLS

Assessment of the coughing patient

For small animal clinicians, assessment of the aged, small breed patient with severe mitral regurgitation and chronic airway disease remains an ongoing challenge. Many of our patients have components of both conditions. Successful therapy depends on understanding the relative contribution of each problem to the cough/tachypnoea.

Echocardiography is never a substitute for careful history taking, a good physical examination and thoracic radiographs +/- airway cytology/culture. Thoracic radiography should be the clinician's choice rather than echocardiography if limited to choosing only one of these modalities. Pulmonary oedema cannot be diagnosed using echocardiography.

Screening for hereditary cardiac disease

Screening is most commonly requested for dilated cardiomyopathy, sub-aortic stenosis, feline hypertrophy cardiomyopathy and myxomatous mitral valve disease (Cavalier King Charles Spaniels). These assessments are ideally performed by cardiologists or specialists with advanced echocardiographic skills and cardiology knowledge. Judging genotype based on phenotypic changes is always difficult to defend, but in the absence of reliable genetic markers for these conditions it is the best practical tool available.

Canine dilated cardiomyopathy screening for occult disease is problematic. The use of systolic function indices and chamber dimension guidelines vary between breeds and between researchers. The findings do not make the patient 'cardio-free' as the cardiac status can change over the following year. 24 hour Holter monitors are ideally used in conjunction with echo assessment to give a more accurate assessment of the patient's status in some breeds (eg Boxers and Dobermans).

Sub-aortic stenosis detection in the patient with a soft basilar systolic murmur and equivocal Doppler results in the exam setting of elevated sympathetic tone is a diagnostic minefield with significant implications for the breeder/owner and the cardiac health of the breed.

Feline hypertrophic cardiomyopathy screening in the future is likely to be assisted by the identification of gene mutations, such as has occurred in the Maine Coon breed. Screening by echo is complex given the both the variety of phenotypes and the subtle nature of early disease. Minor abnormalities of papillary muscle architecture, intermittent systolic anterior motion of the mitral valve and mild focal wall hypertrophy are early markers for this condition that require considerable skill to accurately assess.

International screening guidelines for myxomatous mitral valve disease in Cavalier King Charles Spaniels recommend auscultation, not echo. Infrequently, echocardiography may be required to confirm the cause of the murmur. In patients without a murmur, echocardiography may demonstrate mitral valve prolapse and early mitral valve regurgitation. Geneticists propose that if this potentially large group of dogs were removed from the breeding population, the negative effect on the gene pool would in the longer term result in an adverse outcome for the breed.

Specific cardiac diseases

Degenerative mitral valve disease*:* as previously discussed, thoracic radiographs are mandatory in these patients, particularly when assessing a cough. Patients with recent chordae rupture may present with only mildly enlarged left heart chambers, leading the clinician to underestimate the potential for pulmonary oedema. Conversely, patients with extraordinary left heart enlargement may not be in heart failure.

Medium and large breed patients with severe mitral regurgitation may present with minimal mitral valve thickening, atrial fibrillation and severe systolic dysfunction, leading the clinician towards an erroneous diagnosis of dilated cardiomyopathy.
Echocardiography in the aged, small breed patient with typical clinical and radiographic findings offers minimal information to the clinician unless the echocardiographer can offer more advanced insights into the disease process. Examples include the estimation

of systemic and pulmonary systolic pressures via the Bernoulli equation, systolic function assessment (other than fractional shortening), left atrial pressure estimation and regurgitant jet quantification.

***Dilated cardiomyopathy**:* some of the limitations and pitfalls have been previously mentioned. Over-interpretation of fractional shortening parameters is a common error with this presentation. It is too simplistic to consider a fractional shortening (FS) of 27% or 30% as a 'cut-off' between normal and abnormal systolic function. This parameter is influenced by breed, concurrent valve disease, cardiac loading conditions, operator skill, arrhythmias, heart rate and global versus regional ventricular dysfunction. The echocardiographer should be familiar with other systolic function indices such as percent left ventricular area shortening, end-systolic volume indices, E-point septal separation etc..

Patients with moderate systolic dysfunction (eg FS of 20%) can be erroneously diagnosed with heart failure as a cause of respiratory signs or marked weakness. In the absence of concurrent cardiac disease (eg severe mitral regurgitation, advanced diastolic dysfunction) myocardial systolic impairment is typically more advanced before heart failure occurs.

***Congenital cardiac disease**:* where available, all patients with congenital cardiac disease should be assessed by a specialist with advanced echocardiography and cardiology skills. It is no longer satisfactory to merely identify the type of defect. Additional information regarding quantification of severity, suitability for surgical correction (eg. patent ductus arteriosus morphology, pulmonic valve hinge diameters, pre-operative detection of R2A coronary anomalies), medical treatment options and prognosis are all required to meet the current standards of cardiac assessment.

***Feline Cardiac disease**:* the complexities of feline cardiac disease have already been mentioned. Apart from advanced left ventricular hypertrophy (LVH), all other feline presentations are challenging to interpret. LVH may be due to hypertrophic cardiomyopathy, neoplasia, aortic stenosis, hyperthyroidism or systemic hypertension. Doppler tissue imaging is unable to reliably differentiate between these causes of LVH.

Restrictive cardiomyopathy is a complex presentation, with considerable overlap in terms of echo appearance with atypical phenotypes of hypertrophic cardiomyopathy, persistent atrial standstill, myocarditis and endomyocardial fibrosis. The echocardiographer would ideally be familiar with the quantification of diastolic dysfunction by Doppler tissue imaging or newer strain rate assessment technology.

***Pericardial disease**:* the decision to treat or euthanase patients with pericardial effusion is often reliant on the echocardiographer's ability to accurately identify neoplasia. There is potential for neoplastic disease that may not be sonographically visible such as mesothelioma. This prevents a definitive rule-out of neoplasia based on echocardiography alone. In addition, the reduced window available for echo exams performed post-centesis may not allow the diagnosis of small mass lesions. Erroneous interpretation of fatty deposits as mass lesions of the pericardium, heart base and AV grooves may also lead to misdiagnoses.