Cardiomyopathy screening in shelter cats for rehoming

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The rehoming of both stray and unwanted cats through veterinary charities and practices is a remarkably successful, noble initiative that reflects the profession and public’s compassionate generosity towards our feline companions. In 2014, around 200,000 cats were successfully rehomed through these channels.

However, not all rehomed or rehomeable cats are perfect feline specimens, and there is a distinct clinical mystery around most animals. Clinical histories may be absent (strays), incomplete or unavailable (unwanteds). While some clinical abnormalities are easily identified, quantified and prognosticated, one of the most tricky and controversial areas surrounds cardiomyopathy, especially when a murmur is identified.

This article details the author’s approach to these cases, drawing on the relevant evidence base and providing a practical, ethical and legally compliant outline for dealing with cardiomyopathic cats. It will focus primarily on adult, asymptomatic cats.

Cardiomyopathy prevalence
What is the prevalence of cardiomyopathy in the general cat population? The short answer is nobody knows – for several reasons. Very few studies have attempted to estimate it; the studies that have tried generally use small numbers and different classification criteria. Disagreement exists about classification criteria (one cardiologist’s unclassified will be another’s restrictive, and another’s normal), and cardiomyopathy is a broad church of pathological and phenotypic definitions. Regarding this, most authors use classifications of hypertrophic (HCM), restrictive (RCM), dilated (DCM), arrhythmogenic right ventricular (ARVC) and unclassified (UCM) cardiomyopathy, and these will be used here. Full discussion of classification criteria is beyond the scope of this article, but several excellent reviews exist\textsuperscript{1–3}.

Studies have estimated the prevalence of cardiomyopathy in the cat population (Table 1). Most relevant to the shelter environment are those by Wagner et al, which reported a prevalence of 34%
for HCM, and Paige et al, which reported a prevalence of 16% for cardiomyopathy (15% for HCM, 1% ARVC) in healthy cat populations. The prevalence of cardiomyopathies other than HCM is difficult to define. In a study of symptomatic cats, Ferasin et al reported distribution of RCM 20.7%, DCM 10.4%, UCM 10.4% (and HCM 57.5%), but no studies have described prevalence in healthy populations.

Heart murmurs and cardiomyopathy

The most common reason for suspecting cardiomyopathy in a shelter cat is the detection of a heart murmur, but does a heart murmur indicate a cardiomyopathy? Published studies (Table 1) indicate while an association is found between detection of a heart murmur and presence of underlying cardiomyopathy, the predictive value of a heart murmur for cardiomyopathy is poor.

For cats with murmurs, a cardiomyopathy was present in 31% to 53% of cats, and in an unpublished study by the author of 72 healthy shelter cats with murmurs, 47% had cardiomyopathy: overall, it seems presence of a heart murmur carries no more predictive value of cardiomyopathy than tossing a coin.

These studies also indicate the grade of murmur carries little predictive value for cardiomyopathy presence or severity. Partly, this may be explained by sympathetic stimulation during examination artificially increasing murmur grade, and partly because many benign cardiomyopathies (especially those displaying isolated outflow obstruction) can have impressively loud murmurs.

The converse of the murmur-cardiomyopathy association is that not all cats with cardiomyopathy have murmurs. In the studies by Wagner et al and Paige et al, 69% and 16% of cats with cardiomyopathy had no detectable murmur, respectively.

Table 1. Studies of prevalence of heart murmurs, cardiomyopathies and their association.

<table>
<thead>
<tr>
<th>Study</th>
<th>Cats with cardiomyopathy</th>
<th>Cats with murmur</th>
<th>Cats with murmur and cardiomyopathy</th>
<th>Cardiomyopathy without murmur</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wagner et al (2010)</td>
<td>102</td>
<td>16</td>
<td>60</td>
<td>52</td>
<td>Healthy cats PPV 31%</td>
</tr>
<tr>
<td>Ferasin et al (2006)</td>
<td>32</td>
<td>17</td>
<td>22</td>
<td>11</td>
<td>Healthy cats PPV 31%</td>
</tr>
<tr>
<td>Ferasin et al (2006)</td>
<td>92</td>
<td>21</td>
<td>61</td>
<td>20</td>
<td>Healthy cats PPV 31%</td>
</tr>
</tbody>
</table>

PPV: positive predictive value of a heart murmur for cardiomyopathy presence, i.e. percentage of cats with murmur that had a cardiomyopathy. PPV: percentage of cats with a cardiomyopathy that had a heart murmur.

The source of murmurs without detectable cardiomyopathy, other structural heart disease or abnormal blood movement – for example, ventricular septal defect, mitral valve disease, systolic anterior motion of the mitral valve (SAM) or mitral regurgitation – remains incompletely explained.

One theory is these represent vibrational or flow murmurs: as the blood flows past the relatively stiff intervertebral septum muscle (IVS) in parallel direction, it causes a drop in pressure that “sucks” the IVS towards the left ventricle lumen (the Bernoulli, Coandă? or “shower curtain” effect). The
The relative stiffness of the IVS allows only a slight deviation, which causes both a small degree of blood turbulence and muscular vibration, the summation of which creates the murmur.

The relatively more elastic kitten IVS may explain why young cats can have murmurs that disappear in adulthood. Dynamic right ventricular outflow tract obstruction may also be underdiagnosed in adult cats.

**Diagnosing and prognosticating cardiomyopathy**

The gold standard for diagnosis, staging and prognosticating in cardiomyopathy is echocardiography.

### Table 2. Criteria for classification of feline cardiomyopathies

<table>
<thead>
<tr>
<th>Cardiomyopathy</th>
<th>Echocardiographic features</th>
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<tbody>
<tr>
<td>HCM</td>
<td>Any wall segment diastolic &gt;6mm.</td>
</tr>
</tbody>
</table>
| HOCM           | SAM: Subaortic region of diastolic IVS >6mm.  
|                | +/- Abrupt aortic tract acceleration  
|                | (“scimitar-type” shape on Doppler).  
|                | +/- mitral regurgitant jet. |
| RCM            | Biventricular enlargement.  
|                | Absence of hypertrophy.  
|                | “Restrictive” filling pattern.  
|                | +/- mixed myocardial echogenicity. |
| DCM            | (B) biventricular enlargement.  
|                | Increased end-systolic LV diameter >14mm.  
|                | FS%<28 |
| ARVC           | RV enlargement +/- RA enlargement.  
|                | AF or complex VT.  
|                | RV hypokinesia. |
| UCM            | Abnormalities not fitting into above classifications, such as segmental wall thinning.  
|                | Hypokinesia, isolated myocardial abnormalities. |

*IVS = interventricular septum. SAM = systolic anterior motion of the mitral valve. RV = right ventricle. AF = atrial fibrillation. VT = ventricular tachycardia.*

While biomarkers are gaining in popularity they lack sufficient sensitivity to accurately classify and prognosticate cardiomyopathy, and so are of limited use in the shelter environment. Any cats with HCM should have blood pressure measurement, and, if in an at risk age group, total T4. An electrocardiogram is indicated where ARVC is suspected.

Feline echocardiography is well described in several texts. However, the overriding rule with
echocardiography is not all that is measurable is important and not all that is important is measurable – cardiologists love numbers, but in the context of shelter screening, there are only a few useful measurements, and subjective assessment plays a vital role in deciding on rehomeability.

In the author’s opinion, screening cats for cardiomyopathy and subsequent rehomeability is within the competence of general practitioners with sufficient basic training.

As mentioned, the classification of cardiomyopathy is controversial. The author’s basic criteria for different cardiomyopathies are set out in Table 2. Prognostication in cases of cardiomyopathy has been defined. Put simply, for shelter cats, prognosis for RCM, DCM, ARVC and UCM is at worst awful, and at best very unpredictable so these would not be considered suitable for rehoming.

HCM offers a more optimistic prognosis. In a retrospective study of 127 cats by Payne et al$^7$, healthy HCM cats with or without SAM showed a long asymptomatic phase, with median survival greater than 3,617 days (more than nine years) for HCM plus SAM, and greater than 2,574 days for HCM-SAM (more than seven years), with differences in survival not reaching significance (p=0.345).

Negative prognostic indicators were evidence of left atrial enlargement (left atrium:aorta greater than 1.5) and presence of symptoms (evidence of congestive heart failure). Interestingly, degree of wall thickening was not shown to affect prognosis.

### Table 3. Features of cats with HCM that would make them unrehomeable.

<table>
<thead>
<tr>
<th>Features of HCM indicating unrehomeable</th>
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<tbody>
<tr>
<td>Signs of heart failure</td>
</tr>
<tr>
<td>LA&gt;15 mm or LA:Ao&gt;1.5</td>
</tr>
<tr>
<td>Evidence of arrhythmia</td>
</tr>
<tr>
<td>Evidence of abnormal focal or global wall movement, infarctions or extensive scarring</td>
</tr>
<tr>
<td>Hypertrophy exceeding 9mm at any point</td>
</tr>
<tr>
<td>Abnormal LV diastolic function on transmitral flow velocity patterns</td>
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Table 3. Features of cats with HCM that would make them unrehomeable.

Subjective assessment of general cardiac function is especially useful to detect differences in myocardial echogenecity (for example, increased is suggestive of fibrosis or scarring, reduced suggests infarctive lesions), movement dyskinesia, akinesis, hypokinesis or asynchrony, and general qualitative function. Overall, prognostication remains inexact.
Criteria for non-rehomeability are set out in Table 3. While we have evidence of a long asymptomatic phase of HCM, this does not directly transfer to being able to say with certainty which cats will enjoy prospectively such a long phase in a new home, especially as we usually have no clinical history indicating the chronicity or otherwise of the cardiomyopathy.

However, the emphasis of shelter screening is to detect those cats definitely unsuitable for rehoming at that point in time. A pragmatic, beneficent view for those suffering from mild asymptomatic disease is to say it is probable they will enjoy a long asymptomatic phase, but the course of natural disease is unpredictable due to as yet unknown and unidentified genetic and environmental influences.

**Cat selection for echocardiography**

Given the poor correlation of heart murmur with cardiomyopathy, there is a strong case for screening, via echocardiography, each cat that is due to be rehomed.

However, in a shelter environment where there is distinct pressure on throughput of animals, this is unlikely to be practical. Therefore, a pragmatic approach would be to scan all animals with murmurs, possibly those estimated to be middle aged or old, and all male cats, given the latter’s predisposition (over twice as likely as female cats) to HCM4,7.

**Other cardiac diseases**

This article deals with cardiomyopathies, but, of course, cats can suffer from a range of congenital or acquired heart diseases. However, in the author’s experience, these appear to be rare in the shelter environment – in more than 500 animals assessed echocardiographically for rehoming, only two have had a VSD, one mitral valve dysplasia, and one cor triatriatum sinister.

Kittens with murmurs can be troublesome. The vast majority of these appear to be innocent “flow” murmurs (as discussed previously), and normally resolve as the animal grows, often in a matter of weeks. If the animal is due to be rehomed, it is wise to scan these animals for congenital abnormalities, while appreciating this would not necessarily be done for an owned animal in many cases in general practice.

**Ethics and legalities**
Figure 2. This cat had no murmur, but had mild HCM. It was rehomed successfully.

The Sale of Goods Act 1979 covers the rehoming of cats where a fee is charged, as is common in rehoming charities. According to this act, the item (cat) should be “as described”, meaning no problems should arise if the new owner is made aware of the condition with the fullest information available at that time. This would need to include a statement regarding our incomplete knowledge of the progression and prognosis for cardiomyopathies in cats. Liability for future treatment of problems arising from the “defect” should also be clearly stated. Such a description of the condition and scientific knowledge regarding it should also allow an informed choice for the owner, meaning ethical problems with rehoming “defective” cats are reduced.

There is an argument from justice ethics that given the high number of healthy animals waiting for rehoming, cats with an unpredictable defect should not be rehomed ahead of these. However, this essentially utilitarian viewpoint neglects the probable long asymptomatic phase most cardiomyopathy cats may be expected to enjoy; further, the routine euthanasia of any shelter cats with any defect is both unpalatable and unsupportable ethically or scientifically.

**Cardiomyopathy and rehomeability**

One small American study abstract detailed 100 shelter cats, 10 of which had heart murmurs and two had defined cardiomyopathy; it failed to show any negative influence of murmur presence or cardiomyopathy on speed or success of rehoming8. Larger studies are required to see whether this holds in larger numbers, but intriguingly cats with cardiomyopathy may enjoy the same positive selection bias as their one-eyed and three-legged counterparts.

**Follow-ups**

The change of a cardiomyopathy over time may give some prognostic information about the likeliness of future development of clinical signs. Therefore, repeat echocardiographic examinations every six to 12 months would be advisable.
Conclusion

Cats presenting to shelters with murmurs, cardiomyopathies or both can be difficult to make ethically justified rehoming decisions about. A systematic approach, with periodic review of protocols and the relevant scientific literature, can provide a consistent and compassionate outcome in which the individual, population and new owners are best served.

References