Histopathologic frequency of feline hepatobiliary disease in the United Kingdom

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Abstract

Objectives: To determine the histopathologic frequency of feline hepatobiliary diseases in the UK and to identify breed, age and gender predispositions to developing individual diseases.

Methods: Histopathology results from 1452 feline liver biopsies were assessed. A control population of microchipped cats was used for breed comparison. Data was retrospectively categorised into hepatobiliary diseases according to World Small Animal Veterinary Association standards. Odds ratios and 95% confidence intervals were calculated to determine breed predispositions to the ten most frequent diseases. Gender and age distributions were also evaluated.

Results: The most frequent diseases based on histopathology were neutrophilic cholangitis (20.5%), reactive hepatitis (20.4%), reversible hepatocellular injury (8.4%), lymphocytic cholangitis (6.8%), biliary cysts (5.7%), acute hepatitis (5.6%), haematopoietic neoplasia (5.6%), hepatocellular neoplasia (4.9%), congenital portosystemic shunt (3.8%) and cholangiocellular neoplasia (3.1%). Some previously unreported breed and age predispositions were identified.

Clinical significance: This is the first study to document the histopathologic frequency of hepatobiliary diseases in a large cohort of cats in the UK, as well as novel breed and age predispositions. These data may help to increase the index of suspicion of a particular disease in the absence of a biopsy-confirmed diagnosis.

Keywords: Hepatology; Histopathology; Cat; Feline; Liver.

Introduction

Feline hepatobiliary disease is common, although there have been no comprehensive studies to determine the histopathologic frequency of the different diseases, nor breed, age and gender distributions in the United Kingdom. In part the World Small Animal Veterinary Association (WSAVA) Liver Standardization Project (Rothuizen *et al.* 2006b) was initiated to provide well-defined histological criteria for liver diseases of dogs and cats, morphologically grouping diseases into vascular, biliary, parenchymal or neoplastic disorders. Vascular disorders can be divided into congenital portosystemic shunts (cPSS), outflow disorders resulting in congestion, and disorders with portal hypertension. Within biliary tract diseases there are sub-categories for cholestasis, biliary cysts, neutrophilic cholangitis, lymphocytic cholangitis and cholecystitis. The largest category is parenchymal disorders and this can be sub-divided into a further seven groups. These include amyloidosis, acute, chronic and reactive hepatitis, abscesses, metabolic storage diseases, hepatocellular death, reversible hepatocellular injury and miscellaneous findings. Reversible hepatocellular injury is a large category encompassing hepatic lipidosis, steroid-induced hepatopathy and cloudy swelling secondary to systemic disease. Finally, the neoplastic group is composed of hepatocellular, cholangiocellular, primary vascular and mesenchymal, haematopoietic, hepatic carcinoids and those neoplasms of metastatic origin.

To the best of our knowledge there has only been one previous study evaluating breed, age and gender predispositions to feline hepatobiliary disease. With a sample size of 71 feline liver biopsies in Japan, Hirose *et al.* (2014) found the most frequent morphological diagnosis to be parenchymal and interstitial hepatitis, which represented 45.1% cases. Neutrophilic cholangiohepatitis was the second most frequent (23.9%) followed by lymphocytic cholangiohepatitis (14.1%). The only study investigating the histopathologic frequency of different hepatobiliary diseases was performed in the USA on 175 liver biopsy samples

(Gagne *et al.* 1996). The most common diagnosis was hepatic lipidosis (49%), while cholangiohepatitis represented 26% of cases.

Liver biopsies are generally accepted as the gold-standard for diagnosing hepatobiliary diseases (Cocker *et al.* 2017). Awareness of the histopathologic frequency of different feline hepatobiliary diseases, and data on breed, age and gender predispositions, may help to increase a veterinary surgeon's index of suspicion of a particular disease in the absence of a biopsy-confirmed diagnosis. This will help guide optimal management and improve patient outcome. The first aim of this retrospective study was therefore to determine the histopathologic frequency of hepatobiliary diseases in a large cohort of cats in the UK. A second aim was to determine breed, age and gender distributions within these hepatobiliary diseases.

Materials and Methods

This project has been approved by the University of XXX Ethical Review Panel. Histopathology data were provided by XXX from liver tissues submitted between 4th November 2008 and 30th September 2015 by primary care and secondary referral centres throughout the UK. These collection dates represent the laboratory's first recorded submission of liver tissue until initiation of the study. Details included breed, age, gender, gross and histological descriptions, diagnosis and additional comments. The method by which liver tissue was collected was not always detailed. Histopathological analysis was performed by board-certified anatomic pathologists. Cases that did not have age or gender details were included in the study when the breed was documented as data was still relevant for breed analysis. Records where the breed was not recorded were also retained for analysis of age and gender distribution. Cases were excluded if the results of

histopathology were non-diagnostic, if there was no evidence of significant liver disease or if the sample was from a non-domestic feline species. Cases were grouped into 23 categories according to WSAVA histological criteria for feline hepatobiliary diseases, using the four main headings of vascular, biliary, parenchymal and neoplastic disorders. When cases demonstrated histological evidence of more than one primary liver disease they were placed in all appropriate categories. The categories were then ranked by frequency and the ten most common morphological diagnoses were identified. Within these ten categories breed analysis was performed on all breeds with five or more cases. For purposes of breed analysis, this study used a UK-based control population consisting of all cats registered with a national microchip company between 2009-2015^a. This control population comprised of 1,844,541 cats for which only breed and gender information was available. Within each disease category, the number of each breed was compared with the number of that breed present in the control population as a whole, thus attempting to compensate for variations in the popularity of different breeds.

Statistical analysis:

All statistical analyses were performed in R (R Development Core Team 2013, Available at: <http://www.R-project.org/>). Odds ratios (ORs), 95% confidence intervals (CIs) and P-values are reported. Adjustments for multiple testing was done via the Sidak method (Abdi 2007). Statistical significance was evaluated at the 5% significance level. Breeds shown to be predisposed to an individual liver disease had ORs and 95% CIs > 1.0. A breed was considered protected against an individual liver disease with ORs and 95% CIs < 1.0. The age and gender data are presented for all breeds within the ten most common morphological diagnoses found in the study. Age data is presented as minimum, 1st quartile, median, 3rd quartile and maximum age at diagnosis in months. Gender information is presented as the male to female to unknown ratio for each breed.

Results

Overall histopathologic distribution:

The study consisted of 1,452 histopathology submissions of feline liver tissue. The study excluded 235 submissions, of which 27 were non-diagnostic, 203 were within normal limits and five were from non-domestic feline species. Within the 1,217 samples included in the study, 21 had evidence of two primary liver diseases and therefore account for 42 cases. Although statistical testing was not performed, in the small number of cases with two liver diseases no obvious disease associations were noted. Table 1 shows the overall distribution of cases within each category. The ten most common histopathologic diagnoses in order of frequency were neutrophilic cholangitis (20.5%), reactive hepatitis (20.4%), reversible hepatocellular injury (8.4%), lymphocytic cholangitis (6.8%), biliary cysts (5.7%), acute hepatitis (5.6%), haematopoietic neoplasia (5.6%), hepatocellular neoplasia (4.9%), congenital portosystemic shunt (3.8%) and cholangiocellular neoplasia (3.1%). The reversible hepatocellular injury category contained 106 cases, of which 50 (47.1%) were morphologically diagnosed with hepatic lipidosis, 30 (28.3%) with vacuolar hepatopathy and 26 (24.6%) with cloudy swelling. Within the haematopoietic neoplasia category, all 70 cases were diagnosed with hepatic lymphoma. Hepatocellular neoplasia had 56 cases (90.3%) classified as hepatocellular carcinoma and 6 (9.7%) diagnosed with hepatocellular adenoma. Within the cholangiocellular neoplasia group of 39 cases, 25 (64.0%) were diagnosed with cholangiocarcinoma and 14 (35.9%) with cholangioadenoma. No cases of hepatic abscessation were documented.

Breed distribution:

Breed distributions to the ten most frequently identified histopathologic diagnoses are detailed in Table 2. The most frequently identified histopathologic diagnosis was neutrophilic

cholangitis, and breeds shown to be at an increased risk included the British shorthair (BSH), Burmese, domestic longhair (DLH), Persian, and Siamese, while domestic shorthair (DSH) have a reduced risk. Breeds shown to have an increased risk of reactive hepatitis included Birman, Burmese and Siamese and, again, the DSH was shown to have a reduced risk. Within the reversible hepatocellular injury category only Siamese were shown to be at an increased risk, while DSH have a reduced risk compared to the control population. No breeds were shown to have an increased or reduced risk for lymphocytic cholangitis. The sixth most frequent histopathologic diagnosis was biliary cysts, with BSH and Persians shown to be at an increased risk while DSH have a reduced risk. The only breed found to have an increased risk for a diagnosis of acute hepatitis was the BSH, while DSH were shown to be at a reduced risk. No breeds were shown to have an increased or reduced risk for haematopoietic or hepatocellular neoplasia. The ninth most frequent histopathologic diagnosis in this study was cPSS, with an increased risk found for BSH, while the DSH appeared to have a reduced risk. The final hepatobiliary disease for which breed analysis was performed was cholangiocellular neoplasia. As with the previous disease group, BSH were shown to be at increased risk and DSH have a reduced risk.

Gender and age distribution:

Table 3 shows the male to female to unknown ratio of breeds with more than five cases for the ten most common histopathologic diagnoses. Statistical analysis was not performed comparing gender ratios with the control population due to the small number of cases of each breed within the disease categories, resulting in very little power in testing any gender predisposition for those diseases. However, visual evaluation suggests that male DSH may be predisposed to reactive hepatitis, biliary cysts, acute hepatitis and hepatocellular neoplasia compared to females.

On evaluation of the age data, neutrophilic cholangitis appears to be a disease of young to middle aged cats, with a median age at diagnosis of 110 months (9.2 years). Bengals were diagnosed with neutrophilic cholangitis younger than other breeds in the study with a median age of 36 months (3 years). Lymphocytic cholangitis is diagnosed more frequently in middle aged cats, with a median age at diagnosis of 132 months (11 years). Biliary cysts appear to be most commonly diagnosed in middle aged to older cats (range: 1 – 240 months), while acute hepatitis appears to be a disease primarily affecting younger individuals. Hepatocellular, cholangiocellular and haematopoietic neoplasia were diagnosed more frequently in older patients, while cPSS has a young median age of 9 months.

Discussion

This study is the first to report the histopathologic frequency of hepatobiliary diseases in a large cohort of cats in the UK. Moreover, the results also suggest several previously unreported breed and age associations, as well as clarifying a number of anecdotally reported predispositions. We found the most common hepatobiliary disease to be neutrophilic cholangitis, previously termed suppurative cholangitis, a result which contrasts investigations from the USA which show a predominance of hepatic lipidosis (Gagne *et al.* 1996). Those breeds found to be significantly over-represented for neutrophilic cholangitis include oriental breeds such as Burmese, Persians and Siamese, as well as the BSH. To our knowledge, this predisposition has not been previously documented and warrants further investigation. Interestingly the BSH is thought to have been bred extensively with Persians in the early 20th century, thus increasing the genetic similarity between the two breeds (Kurushima *et al.* 2013). In view of the aetiology of this condition (Forman 2017), it is possible that these breeds may have anatomical differences facilitating ascending bacterial infection, or an inability to clear bacteria from the biliary system. Interestingly, a study in Switzerland investigating feline pancreatitis found that of 161 cases the most common

breeds were DSH (n = 120), Persian (n = 9) and BSH (n = 5) with Siamese (n = 2) and Siamese-mix cats (n = 2) also noted (Oppliger *et al.* 2014). Unfortunately, there was no control population used for comparison so it is difficult to ascertain if these were truly over-represented breeds. However, if these breeds are over-represented this may support the theory that oriental breeds have an increased risk of ascending bacterial infection of the common bile duct, leading to neutrophilic cholangitis and pancreatitis. With a median age at diagnosis of 110 months, neutrophilic cholangitis is a disease primarily affecting young to middle-aged cats which supports data from a previous study (Callahan Clark *et al.* 2011). Although acute and chronic forms of neutrophilic cholangitis have been reported, the WSAVA liver standardisation project did not categorise these as separate diseases, and therefore this study allocated all cases to a single category. Furthermore, it would be challenging to reliably define at what point the condition transitions from acute to chronic based purely on histology. In order to better evaluate this differentiation, and to determine any breed, age or gender predispositions for these individual sub-types of neutrophilic cholangitis, quantitative values would need to be predetermined in order to reliably allocate each case to the acute or chronic form of disease.

A study looking specifically at reactive hepatitis in dogs found it occurs in response to conditions affecting the urinary, reproductive, cardio-respiratory and gastrointestinal tracts, as well as endocrine disease (Neumann *et al.* 2012). If the same is true in cats, it is not surprising that this was a common histopathologic diagnosis. Although this study did not have the additional data required to determine the cause of reactive hepatitis, it is interesting to note that significant numbers of cats underwent liver biopsy in the absence of a primary liver disease. Acute hepatitis is a morphological diagnosis covering a range of disease processes that cause hepatocellular apoptosis, necrosis and inflammation. Potential aetiologies include feline infectious peritonitis, feline herpes virus, bacteraemia, *Toxoplasma*

gondii and various drug toxicities (Forman 2017). In this current study, the pathologists alluded to the likely causative agent in most cases, but without further testing the aetiology could not be definitively diagnosed. The results in this study suggest a very low occurrence of chronic hepatitis within the UK cat population, comprising only 2.4% total study population. This contrasts to dogs, in which chronic hepatitis is a common histological diagnosis with a prevalence of 12% at *post mortem* (Watson *et al.* 2010; Poldervaart *et al.* 2009). A previous study has also identified several breed predispositions to canine chronic hepatitis, suggesting a possible genetic component (Bexfield *et al.* 2012). While breed analysis was not performed for feline chronic hepatitis in this study, it would be interesting to investigate this in the future with a larger data set.

In the category of reversible hepatocellular injury, this study found that the proportion of cases of hepatic lipidosis is considerably less than that reported in a study from the USA (Gagne *et al.* 1996) where the disease was identified in 49% of feline liver histology samples in a population of 175 cats. Reasons for this variation between the UK and USA may be genetic, dietary or due to environmental differences (Cocker *et al.* 2017). Furthermore, it must be noted that this current study looked only at histopathology and not cytology data. It is possible that cases of hepatic lipidosis are being diagnosed using clinical signs, serum biochemistry and cytology, and may therefore not progress to liver biopsy. Compared to the USA, clinicians in the UK may feel more comfortable diagnosing hepatic lipidosis without a liver biopsy, and this may be another reason for the variation between the two countries. Unfortunately, on histopathology alone it is not possible to distinguish primary hepatic lipidosis from lipidosis secondary to another disease process.

Interestingly this study found no breed predispositions for lymphocytic cholangitis, a disease with a previous association with Persian cats in the UK (Davies *et al.* 1984). Previous studies have found contrasting results for the age distribution of lymphocytic cholangitis with one study in Japan demonstrating a moderately young median age of 5 years and 1 month (Hirose *et al.* 2014), however this consisted primarily of Japanese DSH and therefore may not be directly comparable. In the UK, this disease is said to more frequently affect older cats (Callahan Clark *et al.* 2011), and the results of this current study support this with a median age at diagnosis of 11 years. However, the age at diagnosis ranged from 11 – 234 months which suggests that this disease should not be discounted in younger individuals. Furthermore, there is considerable overlap in the age range at diagnosis with neutrophilic cholangitis (4 – 222 months), which suggests that age alone cannot differentiate the two disease processes. A notable limitation with this study is that further evaluation was not performed to definitively differentiate lymphocytic cholangitis from lymphoma. Having said that, the anatomic pathologists involved made it clear in their comments if they were unsure of the diagnosis and these cases were then excluded as non-diagnostic.

A significant over-representation of biliary cysts was found in BSH and Persians. Previous research has shown Persians and Persian-cross cats to be predisposed to polycystic kidney (PKD) disease due to an autosomal dominant mutation, and this mutation is thought to also contribute to development of biliary cysts (Eaton *et al.* 1997). A recent case series of five BSH cats with PKD identified that two of these animals also expressed the same mutation found in affected Persians, highlighting the genetic similarity between the two breeds (Nivy *et al.* 2015). The clinical relevance of biliary cysts is not always clear. A retrospective study of *post mortem* findings from 27 cats with PKD and/or polycystic liver disease found that of 10 cats with biliary cysts none had clinical signs of hepatobiliary disease (Bosje *et al.* 1998).

Feline haematopoietic neoplasia includes a number of tumour types, the most common being lymphoma (Louwerens *et al.* 2005). Less common haematopoietic neoplasms involving the liver include malignant mastocytosis, plasma cell tumour and malignant histiocytosis (Rothuizen *et al.* 2006a), although this current study found no cases of these. The median age of hepatic lymphoma at diagnosis was similar to that found in studies investigating feline extranodal lymphoma (Taylor *et al.* 2009). Previous research into feline lymphoma, although not specifically hepatic lymphoma, has alluded to Siamese and Persian predispositions to the disease but our current study failed to demonstrate significant hepatic lymphoma breed associations (Louwerens *et al.* 2005). A notable limitation with this study, as previously discussed for hepatic lipidosi, is that some hepatic diseases may be diagnosed in practice by liver cytology and may not progress to a biopsy. This is equally true for hepatic lymphoma and therefore this disease may be more prevalent in the UK cat population than our study currently suggests. The only hepatobiliary neoplasia found to have significant breed predispositions was cholangiocellular neoplasia. Interestingly we found that hepatocellular neoplasia was more common than cholangiocellular neoplasia. This contrasts previous studies investigating feline hepatobiliary neoplasia which suggested cholangiocellular neoplasia to be more common in the cat than hepatocellular (Patnaik 1992, van Sprundel *et al.* 2013). Furthermore our study has demonstrated hepatocellular adenoma to be markedly less frequent than hepatocellular carcinoma, a result which again contradicts a recent study in Europe that categorised feline liver tumours (van Sprundel *et al.* 2014). This latter study found that of 61 cases of feline liver neoplasia, 18 (29.5%) were diagnosed with hepatocellular adenoma, 3 (4.9%) hepatocellular carcinoma, 25 (41.0%) with cholangiocarcinoma and no cases of cholangioadenoma. An association between cholangiocellular carcinoma and both cholangitis (Warren *et al.* 2011) and cystic biliary disease (Callahan Clark *et al.* 2011) has been proposed and it is therefore unsurprising that BSH, which are predisposed to both neutrophilic cholangitis and biliary cysts in this study were shown to have an increased risk for cholangiocellular neoplasia.

The BSH appeared to be predisposed to the development of cPSS. To the best of our knowledge this apparent breed predisposition has not been previously reported. Former studies have suggested that oriental breeds including the Persian, Birman, Burmese, Siamese and Himalayan may be predisposed to cPSS (Hunt 2004, Wolschrijn *et al.* 2000). However, these were small studies and most had no comparison to a control population. A number of investigations have suggested that Persians are predisposed to cPSS (Tivers *et al.* 2011) but this was not apparent in the current study. A limitation of this category is that histologically it is difficult to differentiate a cPSS from primary hypoplasia of the portal vein, hepatic arteriovenous fistula and portal vein obstruction because histological changes are all consistent with hepatic hypoperfusion. There are some histological features which make a cPSS more likely such as hypertrophy and hyperplasia of arteriole endothelium (Rothuizen *et al.* 2006b), and these features prompted a diagnosis of cPSS by the board-certified anatomic pathologists in this study. The lack of published data available suggests that these other hepatic vascular disorders are uncommon in the cat (McConnell *et al.* 2006) but it is possible that some cats categorised with a cPSS did in fact have another vascular abnormality. The disease presents similar to dogs with a wide range of clinical manifestations including neurological, gastrointestinal and urinary signs (Tivers *et al.* 2011). Therefore, clinicians would be wise to have cPSS on their differential list for any young cat, particularly BSH, presenting with these signs.

There are several limitations with this study, one of which is that the control population of microchipped cats is assumed to be representative of the entire UK feline population. Microchipping cats is not mandatory in the UK and therefore this may result in a greater proportion of more expensive, purebred cats being included in the control population relative to the general population. However, this is the largest feline control population currently available in the UK. Furthermore, this study relies on the diagnosis provided by several anatomic pathologists and there may be differences in how they clarify the diseases.

However, all pathologists providing results for this study were board-certified and followed WSAVA standardised guidelines for feline liver histopathology (Rothuizen *et al.* 2006b).

In summary, this study reports the histopathologic frequency of hepatobiliary diseases in a large cohort of UK cats. In addition, we document breed and age predispositions, several of which have not been previously identified. In the absence of a liver biopsy, this data may enable veterinary surgeons to increase their index of suspicion of a particular disease. Data generated will also act as a platform for future studies into the epidemiology of individual diseases and possible genetic reasons for apparent breed predispositions.

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Footnotes

^a PETLOG. The Kennel Club Limited 2017; Registration number 8217778.

Table 1: Distribution of feline hepatobiliary diseases.

Morphological diagnosis	Number of cases	Percentage of total cases
<i>Parenchymal disorders</i>	498	39.6
- Reactive hepatitis	257	20.4
- Reversible hepatocellular injury	106	8.4
- Acute hepatitis	70	5.6
- Chronic hepatitis	30	2.4
- Hepatocellular death	20	1.6
- Miscellaneous	12	1.0
- Amyloidosis	3	0.2
<i>Biliary disorders</i>	456	36.1
- Neutrophilic cholangitis	258	20.5
- Lymphocytic cholangitis	85	6.8
- Biliary cysts	73	5.7
- Cholestasis	34	2.7
- Cholecystitis	6	0.4
<i>Neoplastic disorders</i>	230	18.3
- Haematopoietic	70	5.6
- Hepatocellular	62	4.9
- Cholangiocellular	39	3.1
- Metastatic	30	2.4
- Nodular hyperplasia	16	1.3
- Iævascular and mesenchymal	9	0.7
- Hepatic carcinoids	4	0.3
<i>Vascular disorders</i>	75	6.0
- Congenital portosystemic shunt	48	3.8
- Other vascular diseases	16	1.3
- Passive congestion	11	0.9

Diagnosis	Breed	No. of cases	No. in control population	OR	95% CI	p-value
Neutrophilic cholangitis	BSH	11	33631	2.581	1.27 - 4.71	0.0103
	Burmese	7	10741	5.119	2.03 - 10.73	0.0012
	DLH	33	121818	2.255	1.51 - 3.27	0.0001
	DSH	155	1519289	0.3223	0.24 - 0.43	<0.00005
	Persian	8	15858	3.968	1.69 - 7.96	0.0025
	Siamese	9	18745	3.787	1.71 - 7.32	0.0018
Reactive hepatitis	Birman	8	7355	8.711	3.71 - 17.49	<0.00005
	Burmese	8	10741	5.951	2.53 - 11.95	0.0002
	DSH	165	1519289	0.3895	0.29 - 0.53	<0.00005
	Siamese	9	18745	3.836	1.73 - 7.42	0.0017
Reversible hepatocellular injury	DSH	71	1519289	0.4069	0.24 - 0.706	0.0016
	Siamese	6	18745	6.308	2.25 - 14.32	0.0011
Biliary cysts	BSH	5	33631	3.974	1.25 - 9.78	0.0217
	DSH	44	1519289	0.2156	0.13 - 0.37	<0.00005
	Persian	11	15858	20.75	9.801 - 40.1	<0.00005
Acute hepatitis	BSH	5	33631	4.98	1.55 - 12.43	0.0091
	DSH	41	1519289	0.3226	0.17 - 0.66	0.0022
Congenital portosystemic shunt	BSH	7	33631	10.54	3.90 - 24.5	<0.00005
	DSH	30	1519289	0.0948	0.04 - 0.26	<0.00005
Cholangiocellular neoplasia	BSH	5	33631	9.036	2.70 - 24.05	0.0009
	DSH	25	1519289	0.1106	0.04 - 0.37	0.0009

Table 2: Significant breed associations to individual hepatobiliary diseases.

No: Number, OR: Odds Ratio, CI: Confidence Interval, BSH: British shorthair, DLH: domestic longhair, DSH: domestic shorthair.

Table 3: Gender and age distribution of feline hepatobiliary diseases.

Diagnosis:	Breed:	M:F:U	Minimum age:	1 st Quartile:	Median age:	3 rd Quartile:	Maximum age:
Neutrophilic cholangitis	BSH	6:3:2	31	72	101	120	156
	Burmese	4:3	60	70	94	108.5	128
	DLH	18:14:1	10	85.25	120.5	160.5	200
	DSH	78:68:9	4	72	120	150	222
	Persian	3:5	48	82	96	112	144
	Siamese	4:5	7	58	69	109	132
	Bengal	4:2	12	24	36	62	82
Reactive hepatitis	Birman	2:6	13	21.75	84	99	132
	BSH	4:4	12	68.75	94.5	146.5	175
	Burmese	5:3	33	62.5	110	144	193
	DLH	10:9:1	12	73.75	114	149.2	175
	DSH	92:64:9	4	72	108	144.8	217
	Persian	3:2	48	102	120	124	174
	Siamese	5:4	7	24	113	132	186
Reversible hepatocellular injury	BSH	5:1	10	20.5	40	70	112
	DLH	5:4	30	36	68	102	155
	DSH	30:38:3	2	73	107	149	192
	Siamese	2:4	6	78	84	98.25	140
Lymphocytic cholangitis	DLH	3:6	48	95	136	156	180
	DSH	27:34:2	11	108	132	165.5	234
Biliary cysts	BSH	3:2	80	132	132	132	138
	DLH	3:4	44	91	96	150	240
	DSH	27:16:1	1	120.5	156	179	223
	Persian	6:5	120	125	145	156.8	199
Acute hepatitis	BSH	3:2	4	10	68	74	92
	DLH	6:2	5	21.25	51	84.75	156
	DSH	27:13:1	1	15	36	91.5	180
Haematopoietic neoplasia	DSH	34:21:2	36	124	144	168	212
Hepatocellular neoplasia	DLH	3:2	121	139	145	180	203
	DSH	29:15:3	48	132	151	175.2	234
Congenital portosystemic shunt	BSH	2:5	6	7	9	20	44
	DSH	19:10:1	4	6	18	32.5	132
Cholangiocellular neoplasia	BSH	2:3	132	138	139	141	168
	DSH	8:15:2	24	123	148.5	171	192

M: male, F: female, U: unknown gender, BSH: British shorthair, DLH: domestic longhair, DSH: domestic shorthair. Age data is presented in months.

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