

Alex Rosenwax BVSc.(Hons) MACVSc. (Avian Health)  
Bird & Exotics Veterinarian Green Square  
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The aim of the study was to determine which biochemical blood tests were most likely to be useful adjuncts to the diagnosis of liver disease in parrots. The study focused on whether aspartate transaminase (AST), bile acids or glutamate dehydrogenase (GLDH) individually or in combination were most likely to be elevated in cases where hepatic problems were clinically suspected.

### METHOD

A six month (mid-December 2008 to mid-June 2009) study was performed. The records from pet psittacine birds that had biochemistries done as part of their work up were examined. All samples were collected in lithium heparin and analyzed in a NATA-accredited laboratory (IDEXX Sydney). All birds with AST, GLDH or bile acids values above the reference range were identified. Muscle damage can cause a concurrent increase in AST. In this study any sample with an elevated AST and a creatine phosphokinase (CK) value higher than 1000 IU/L was excluded from the study. Birds with GLDH values of 9 IU/L or greater were included in this study. Cholesterol, glucose, uric acid and total protein were also measured. A total of 30 birds met the study's criteria.

The records of birds with biochemical evidence of liver disease were then searched to determine if they were exhibiting signs of either acute or chronic liver disease. Acute signs of liver disease were defined as hepatomegaly (as detected radiographically or by abdominal palpation) and green urates with or without watery droppings.

Signs of chronic liver disease, including hepatic lipidosis, were defined as liver enlargement or shrinking (on palpation or radiograph), elongation of the rhinotheca, changes in the colour of feathers from green to yellow, skin haemorrhages or haemorrhages in the beak and nails, green or yellow urates and seizures. Signs were then correlated with the biochemical results (Table 1).

## RESULTS

Table 1: Correlation of elevated liver blood biochemical analytes (AST, GLDH and bile acid) with signs of liver disease.

Abnormal Biochemical Results	No. of Birds (n=30*)	Percentage in the category	Signs
GLDH ↑	9	30.0%	One or more signs of chronic hepatic disease
AST ↑ GLDH ↑	7	23.5%	One or more signs of active or chronic hepatic disease
Bile acids ↑	3	10.0%	One or more signs of active or chronic hepatic disease
Bile acids ↑ AST ↑	3	10.0%	One or more signs of active or chronic hepatic disease
AST ↑	8	26.50%	Two birds had signs of hepatic disease, two had signs of chronic hepatic disease and four showed no signs of liver disease

Twenty six of 30 birds with abnormalities in the studied biochemistries showed signs of liver disease. These included all birds with elevations in GLDH and all birds with elevations in the bile acids. Four of the 18 birds (22%) with elevated AST values did not show signs of liver disease. If examined alone, elevation in GLDH concentrations detected 61% of the birds with signs of liver disease, elevations in AST levels detected 54% of birds with signs of liver disease and elevations of bile acids detected 23% of the birds with signs of liver disease. Failure to include GLDH in a hepatic panel would have led to 34% of birds with observable hepatic signs being undetected on biochemical testing. All three analytes, however, would have to be used to detect all of the birds with signs of liver disease.

## DISCUSSION

GLDH is a mitochondrial enzyme that appears to increase with necrosis. GLDH has been suggested to be hepatic specific but not sensitive in many parrot species. However the data suggests that GLDH, if elevated above 9 IU/L, is sensitive for indicating chronic hepatic problems. Further studies are necessary to confirm whether repeat blood tests for GLDH may also be useful in monitoring chronic hepatic problems.

Bile acids are a useful indicator of hepatic function. A recent study suggests that abnormal bile acids are a significant indicator of liver disease but are not accurate as a single test for hepatic function in the earlier stages of disease, but may change in mid to late disease stages (Cray, 2008). However, the results did not include GLDH. Once GLDH is included, the results suggest that while bile acids are an important indicator of chronic hepatic disease, they are not the most significant indicator, as suggested by Cray (2008). Bile acids are also influenced by non-hepatic related factors including breeding status. These results were taken outside of the breeding season. There were no cases seen of mild increase in bile acids and cholesterol related to egg-laying hens.

AST is found in skeletal and cardiac muscle in addition to liver (Cray, 2004) and increased blood concentration are not specific for liver disease. In the study, only four out of eight birds with increased AST and normal CK showed common clinical signs of hepatic disease.

Given that AST blood concentrations persist longer than CK concentrations following muscle injury, the elevations in AST in the birds not showing signs of liver disease may be the result of muscle injury instead. Alternately, liver disease may have been present, but not detectable clinically.

The study excluded seven samples of the original 37 (leaving 30 samples), as they had moderately increased AST and CK (<1000 IU/L). Some AST results in these cases were also only elevated by 4-10 IU/L above the reference range. These samples are considered ambiguous by clinicians in their investigation of hepatic problems (Cray 2004). They may be considered significant in some cases in light of a bird's clinical signs. Only three of the seven birds with increased AST and CK had the common clinical signs of hepatic disease. These mild increases in CK in some of these cases may have been due to stress during handling for blood collection. For this reason, the published final results excluded these samples.

The normal levels of GLDH, as per IDEXX reference ranges, for the majority of psittacine bird species are below 3 IU/L and for some species below 6 IU/L. As with AST, minor increases in GLDH are considered ambiguous on interpretation. To allow for this, the results did not include GLDH levels below 9 IU/L. This set a level for which GLDH is generally considered significant but this is not necessarily a minimum for all psittacine bird species.

The results do not include samples that may have had the classical signs of hepatic disease but failed to show any biochemical changes.

## CONCLUSION

In conclusion, elevations of GLDH and bile acids independently or in combination with each other and/or the AST were specific indicators of signs of liver disease. This study shows that not including GLDH in a chemistry panel will result in the failure to detect significant numbers of birds with signs of liver disease. It is recommended that GLDH should be included in all panels of psittacine birds with signs of chronic hepatic disease. Not including bile acids in a biochemistry panel will also result in a failure to detect a smaller percentage of birds with signs of liver disease. The AST is also a critical analyte, but elevations need to be considered in light of changes in the CK and even when the CK is normal, AST elevation, in some cases, may not indicate liver disease.

## REFERENCES

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