https://doi.org/10.21708/avb.2025.19.3.12602

CASE REPORT

ACTA VETERINARIA BRASILICA

ISSN: 1981-5484

Serum biochemical responses to trauma in a rescued savanna hawk (*Buteogallus meridionalis*): case report

Respostas soro-bioquímicas ao trauma em um gavião-caboclo (*Buteogallus meridionalis*) resgatado: relato de caso

Beatriz Garcia de Sousa[1*], Thiago Xisto de Oliveira[1], Julia Menezes Machado[1], Leonardo Serafim da Silveira[1], Antonio Peixoto Albernaz[1],

ABSTRACT: Traumatic accidents in wild birds are a common reason for admission into veterinary care. Serum clinical biochemistry can offer important information for diagnosis, as it surpasses obstacles such as hidden injuries and the birds' tendency to hide behavioural clinical signs. The objective of this report was to describe the serum biochemical profile of a Buteogallus meridionalis admitted to emergency care after sustaining trauma. Blood samples were collected at 0, 5, 10, 15, 20, and 25 days of treatment and analyzed for alkaline phosphatase, gamma-glutamyl transferase, aspartate aminotransferase, uric acid, and urea. Results were compared with reference values found in the literature. Marked alterations in serum activity were observed in aspartate aminotransferase, uric acid, alkaline phosphatase, and gamma-glutamyl transferase levels. While mainly reflecting on potential musculoskeletal involvement and localized hepatobiliary inflammatory responses, this case highlights both the potential and limitations of serum biochemistry as a tool to clinically assess wild birds that suffered trauma from collision, emphasizing the need for further research to clarify the pathological relevance of certain analytes.

Keywords: avian biochemistry; bird medicine; hepatobiliary injuries; injury markers; blunt trauma.

RESUMO: Acidentes traumáticos em aves selvagens são um motivo comum para admissão na clínica veterinária. A bioquímica clínica sérica pode oferecer informações importantes para o diagnóstico, pois supera obstáculos como lesões ocultas e a tendência das aves de esconder sinais clínicos comportamentais. O objetivo deste relato foi descrever o perfil bioquímico sérico de um Buteogallus meridionalis admitido emergencialmente após sofrer trauma. Amostras de sangue foram coletadas nos dias 0, 5, 10, 15, 20 e 25 de tratamento e analisadas para fosfatase alcalina, gama-glutamil transferase, aspartato aminotransferase, ácido úrico e uréia. Os resultados foram comparados com valores de referência encontrados na literatura. Alterações marcantes na atividade sérica foram observadas nos níveis de aspartato aminotransferase, ácido úrico, fosfatase alcalina e gama-glutamil transferase. Embora reflita principalmente sobre o potencial envolvimento musculoesquelético e respostas inflamatórias hepatobiliares localizadas, este caso destaca tanto o potencial quanto às limitações da bioquímica sérica como uma ferramenta para avaliar clinicamente aves selvagens que sofreram trauma por colisão, enfatizando a necessidade de mais pesquisas para esclarecer a relevância patológica de certos analitos.

Palavras-chave: bioquímica aviária; medicina aviária; lesões hepatobiliares; marcadores de lesão; contusão.

INTRODUCTION

Traumatic accidents are common and often the main cause for admission of raptors and other birds to veterinary centers (Cococcetta *et al*., 2022; Fontoura *et al*., 2023; Rozsypalová *et al*., 2022). However, clinical understanding during veterinary care of these patients is still challenged by several factors, including a lack of adequate theoretical and scientific background for many species, and often a poorly detailed clinical history for each case, which is aggravated by the tendency of birds to mask disease signs (Heatley *et al*., 2001; Raidal, 2020). Internal injuries from concussive traumas may be relevant even if no external lesions are present (Ressel; Hetzel; Ricci, 2016), which likely indicates the potential of complementary tools to overcome the limitations of the physical examination. Clinical biochemistry can be valuable not only for clinical reasoning in suspected trauma, but also in general clinical assessment of birds (Harr, 2002; Heatley *et al*., 2001). However, as clinical biochemistry is still under development and lacking basic data for many species, new discussions and information are significantly important.

Some enzymes are considered markers of changes from trauma, such as alkaline phosphatase, which can signal a response to fractures (Harr, 2002; Raidal, 2020). The pathological condition generated will trigger numerous physiological responses in addition to biochemical analytes directly related to trauma. Depending on the severity of trauma, these physiological responses can also be detected by measuring serum biochemical markers of other systems, such as the renal system (commonly assessed through uric acid and urea in birds) and the hepatobiliary system (measured by analytes such as bile acids, lactate dehydrogenase, aspartate aminotransferase, and gamma-glutamyl transferase) (Cray *et al*., 2008; Harr, 2002).

In this context, this case report describes the main changes and fluctuations in biochemical-serological analytes throughout the veterinary care of a savanna hawk (*B. meridionalis*) that required emergency

[1] State University of Northern Rio de Janeiro, Campos dos Goytacazes, State of Rio de Janeiro, Brazil.

*Corresponding author: beatriztise@gmail.com.

Received: 07/30/2024.
Accepted: 07/07/2025.

care at the Center for Studies and Research in Wild Animals (NEPAS) of the Universidade Estadual do Norte Fluminense Darcy Ribeiro (Uenf), after a collision. Serial blood collections were performed to aid in the diagnosis. This case report is based on a clinical and laboratory approach and was authorized by UENF's Animal Use Ethics Committee (ID 527487).

CASUISTRY - CASE REPORT

An adult savanna hawk (*B. meridionalis*) of unknown sex was rescued by the environmental guard of the municipality of Campos dos Goytacazes (State of Rio de Janeiro), from a market after exhibiting difficulty flying. According to the history, the animal collided with a building in the morning and was rescued and admitted for veterinary care on the same day, arriving to care in the early afternoon. Veterinary management lasted 25 days and followed a standardized emergency approach for free-ranging wild animals (Riley; Barron, 2016). The animal was bright, active and responsive (BAR), and in good body condition score (3 out of 5) with a weight of 700 g during the initial assessment. The frontal shoulder region was swollen, and radiographic imaging showed recent fractures of the left furcula and right coracoid, which were subsequently stabilized with a splint. To restrain movement and promote healing of the fracture, the patient was kept in a PrevTech containment cage (120 x 82 x 60 cm) throughout the course of treatment. Meloxicam (0.5 mg/kg, IM, QID) was given for pain management from the first to the fifteenth day of hospitalization. As the patient showed signs of pain and discomfort, Morphine Sulfate (1.4 mg/kg, IM, BID) was administered to better achieve analgesia, starting on the fourth day and finishing on the fifteenth day. After the fifteenth day, recovery was managed with only dietary supplementation PO (0.5 mL of Hemolitan® Gold and one capsule of compounded Silymarin [20 mg/kg]), both QID, by placing it into the food (chicken and beef liver, chicken gizzard, and chicken breast mixed with water).

The animal remained BAR with good appetite throughout treatment, showing positive progression by day 10 and reaching a stable body weight of 800 g. Two follow-up radiographic evaluations occurred on days 10 and 25. At 25 days, the radiograph revealed consolidation of the coracoid fracture and recovery of flight ability, further confirmed by a flight test. Although the furcula did not consolidate ideally, the clinical case showed significant improvement overall. Functions essential for survival were restored (Heatley *et al.*, 2001), therefore, allowing the release of the animal.

Blood samples were collected at specific intervals during treatment and without fasting (due to logistics and time management on the clinical routine). The first sample was obtained upon intake (day 0), and subsequent samples were collected at five-day intervals until the last day of hospitalization, totaling six collections (at 0, 5, 10, 15, 20, and 25 days). All sampling procedures required at least some level of physical restraint by capturing using protective split leather gloves, except during days 10 and 25, when the blood sampling was performed immediately before the radiograph checkups performed under chemical restraint with Ketamine (10 mg/kg) and Midazolam (0.2 mg/kg) administered via intramuscular. Venipuncture was performed on the ulnar vein (with jugular and medial metatarsal veins as alternatives if the sampling was deemed difficult on the primary choice), using 1- or 3-mL syringes and 13 × 0.55 mm needles. Blood was stored in tubes without anticoagulant, centrifuged at 3200 rpm for 5 minutes in a RDE B-40 (MC16i) centrifuge, and the obtained serum was analyzed immediately on days 0, 10, 15, 20, and 25; exceptionally on day 5, serum was frozen for up to 2 days. The biochemistry measurements were done through spectrophotometry using the A15 BioSystems automated biochemistry analyser. The following analytes were measured: alkaline phosphatase (ALP), gamma-glutamyl transferase (GGT), aspartate aminotransferase (AST), uric acid (UA), and urea (UR). All analytes were processed with Biosystems kits, except GGT, which used a LabTest Diagnóstica S.A. reagent. The biochemistry results are shown in Table 1 and compared to a reference value (RV) for the species (Goulart, 2015).

Table 1 – Biochemistry profile of a rescued *Buteogallus meridionalis*, collected at five-day intervals (D0, D5, D10, D15, D20, D25) from the day of intake until the day of release into the wild, with literature reference values (RV) for comparative purposes. Light blue indicates values below the RV, and light red indicates values above the RV.

	RV	*n*	D0	D5	D10	D15	D20	D25
ALP	21.18 - 76.96	3	28	214	170	145	210	132
GGT	2.01 - 3.33	3	27	3.1	3	2	4.9	2
UA	17.46	3	6.46	23.11	6.15	14.88	3.22	3.51
UR*		3	34	10	3	6	2	IS
AST	219.44 - 289.10	3	660	910	353	302	320	253

ALP: alkaline phosphatase; GGT: gamma-glutamyl transferase; UA: uric acid; UR: urea; AST: aspartate aminotransferase; RV: Reference value for *B. meridionalis* (Goulart, 2015); n: sample size; D[number]: day of sampling. (*): in the absence of an RV, no visual indications were presented for UR; moreover, it was the only analyte not measured on the last day due to insufficient serum (IS) volume. Table elaborated by the authors.

Compared to the RV, results at D0 showed high AST, peaked GGT, and low UA. UA, ALP and AST peaked at D5, while GGT fell within the reference range. High levels of AST persisted at D10; alternately, UA levels decreased again. At D15, uric acid was within the reference range and there were persistent high levels of ALP and AST, which remained high at D20, when GGT presented a slight increase. Meanwhile, UA was below the range and remained decreased at D25, while the increased ALP persisted.

DISCUSSION AND CONCLUSIONS

Elevated AST values, commonly associated with liver and muscle injury (Harr, 2002), were initially attributed to blunt tissue damage from the trauma. Additionally, the daily injectable medications until D15 and physical restraint for blood sampling may have contributed to the increases, especially because handling was difficult due to the patient's volatile

behavior, which is expected from a wild bird (Jaensch; Cullen; Raidal, 2000; Sitdhibutr *et al.*, 2023; Wernick *et al.*, 2014). Nevertheless, a decrease was noted throughout the treatment course and was reported as within the reference range at the last assessment (D25). A potential hepatic injury contributing to the increased AST cannot be excluded; however, the absence of specific markers such as bile acids (Cray *et al*., 2008) limits confident attribution, particularly as muscle injury appears more consistent within the context discussed above.

UA concentrations oscillated in comparison to the RV, but fluctuations were more stable if compared to reference values from a larger sample of another South-American Accipitridae species (Doussang *et al*., 2023). A transient UA increase at D5 was possibly related to mild muscle trauma and myoglobin metabolism, with potential kidney involvement, especially because AST also peaked, although no studies linking muscle damage to elevated UA in birds were found, and the literature generally considers UA elevation a late indicator of kidney disease (Scope; Schwendenwein, 2020). Even though signs of discomfort and pain were noticed around D5, leading to treatment adjustments, no clinical signs of renal impairment were observed, which may challenge this assumption unless future research suggests otherwise. Dehydration can also raise UA levels, yet UR, which is a sensitive dehydration marker in birds (Scope; Schwendenwein, 2020), did not consistently rise alongside UA and mostly decreased over time, except for a slight increase on D15 corresponding to a clinically unnoticed dehydration episode. Postprandial UA changes are known variables that should also be considered (Harr, 2002; Lumeij; Remple, 1991; Scope; Schwendenwein, 2020), but isolated increases are considered unlikely as all samples were taken without fasting. In conclusion, UA fluctuations likely reflected variations in the bird's overall condition, including the unwellness around D5, but renal impairment cannot be definitively identified as the cause, despite remaining the main suspicion.

The results showed a persistent increase in ALP from D5 to D25 compared to the reference values for the species. Regarding the alternative reference values, which seem relatively milder, ALP levels were always bordering the maximum limit range, and considering an overall balance of the values obtained and the clinical case under study, ALP values were always higher or borderline the reference range for the species from D5 onwards. This was deemed compatible with an osteometabolic response to fracture (Mohanapriya *et al*., 2020; Tilgar *et al*., 2008).

The increase in GGT found at D0 was considered significant due to its magnitude and is also increased in comparison to a more sample-loaded reference value from other raptor species (Doussang *et al.*, 2023). On the contrary, the slight increase at D20 was not considered clinically relevant and was within the other reference value. The liver is vulnerable to concussive abdominal trauma (Ressel; Hetzel; Ricci, 2016), thus suspicions were directed towards some form of hepatobiliary lesion. The presence and function of GGT in the hepatobiliary system may indicate that its increase could be due to the release of mediators of localized and/or systemic inflammation following a concussive lesion and subsequent rupture and leaking of cellular membrane contents, which may explain the finding (Harr, 2002; Kunutsor, 2016; Lumeij; Westerhof, 1987). Although the possibility that the GGT increase originated from the kidneys or intestines cannot be ruled out (Braun *et al*., 1983; Harr, 2002), serum GGT is generally not regarded as a reliable marker for detecting abnormalities in these organs. Regardless, the observed elevation could still be attributed to potential blunt abdominal trauma, and the belief of its likely relation to the liver and gallbladder is based on: 1. Both the liver and gallbladder's susceptibility to trauma (Ressel; Hetzel; Ricci, 2016); 2. The most standard attribution of seric GGT to hepatobiliary conditions in birds; and 3. The subsequent sudden reduction in the serum activity of GGT to values within or closer to the reference range, which may also suggest an association between the sole increase of GGT levels at D0 and the collision from a few hours before the sampling. Even so, these assumptions cannot be totally supported by the literature yet, as there are no specific studies and neither a true consensus on GGT reliability as an indicator of biliary conditions in birds (Harr, 2002). Similarly, reports or experimental projects published specifically regarding the potential of GGT in signaling the systemic and/or hepatobiliary response to blunt force trauma in birds are not yet available. However, increased serum GGT activity was noted after experimentally induced hepatic contusion by endoscopy in Psittacula krameri manillensis, although no reasonable conclusions were given for this increase (Williams *et al*., 2012). While studies in birds and other animals are scarce, evidence from human medicine supports this clinical interpretation, as increased serum GGT activity has been associated with concussive hepatobiliary injury following blunt trauma (Zakaria *et al*., 2020). These appear to support the potential relation of GGT with blunt trauma in birds under a generalized context.

Limitations must be disclosed. The lack of an ideal sample size for reference values reduces confidence in interpreting results, which is why comparison with wider parameters from a similar species was used. Hopefully, more accurate parameters for *B. meridionalis* will be available in the future. Additionally, some illness signs are potentially disclosed in the biochemistry profile, especially on D5, but are hard to attribute to a specific cause. As discussed, this is partly due to the uncertainty on the diagnostic value of some chosen analytes. Finally, another challenge is overcoming limitations inherent to wildlife clinical management, where stress from restraint and the often necessary improvisation can introduce variables that affect results. Other veterinary professionals may face these obstacles, and therefore reporting the way in which this case was managed and interpreted may help to delimit what one may experience and should ponder in similar situations.

Overall, the findings are consistent with musculoskeletal response to trauma; however, the GGT increase at D0 raises the possibility of an overlooked signaler of blunt abdominal injury in birds, as only few indirect evidence are available in the literature. Therefore, this report highlights limitations and opportunities in interpreting a wild bird biochemistry profile and aims to inspire further research. Simultaneously, it can also be an example to veterinary professionals of what to possibly expect from similar cases, as it brings to light some commonly observed results of avian serum analytes which could potentially be associated with trauma from collision.

ACKNOWLEDGEMENTS

The research for this case report was funded by the Brazilian National Council for Scientific and Technological Development (CNPq). The authors thank the efforts and work of the members of the Veterinary Clinical Pathology Sector (Animal Clinic and Surgery Laboratory - Uenf) and from the Center for Studies and Research in Wild Animals - NEPAS (Laboratory of Morphology and Animal Pathology - Uenf).

REFERENCES

BRAUN, J. P. *et al*. Gamma Glutamyl Transferase in domestic animals. **Veterinary Research Communications**, v. 6, n. 2, p. 77-90, 1983.

COCOCCETTA, C. *et al.* Causes of Raptor Admission to the Wildlife Rehabilitation Centre in Abruzzo (Central Italy) from 2005–2016. **Animals**, v. 12, n. 15, p. 1916-1937, 2022.

CRAY, C. *et al*. Changes in clinical enzyme activity and bile acid levels in psittacine birds with altered liver function and disease. **Journal of Avian Medicine and Surgery**, v. 22, n. 1, p. 17–24, 2008.

DOUSSANG, D. *et al.* Hematological and serum chemistry reference values of captive Black-chested buzzard eagle (Geranoetus melanoleucus). **Ornitología Neotropical**, v. 34, n. 1, p. 24-28, 2023.

FONTOURA, G. D. R. S. *et al.* Fatal traumatic injuries in free-living wild Passeriformes and Psittaciformes birds in Central Brazil, 2006-2018. **Pesquisa Veterinária Brasileira**, v. 43, e07275, 2023.

GOULART, M. A. **Parâmetros hematológicos, bioquímicos e pesquisa de cepas produtoras de ESBL e carbapenemases em aves de rapina em cativeiro no Brasil.** Dissertação de Mestrado: Programa de Pós Graduação em Ciências Veterinárias. Universidade Federal do Paraná, Curitiba - PR, 2015. 153 p.

HARR, K. E. Clinical chemistry of companion avian species: a review. **Veterinary Clinical Pathology**, v. 31, n. 3, p. 140-151, 2002.

HEATLEY, J. *et al.* Raptor emergency and critical care: assessment and examination. **Compendium on Continuing Education for the Practicing Veterinarian**, v. 23, n. 5, p. 442-448, 2001.

JAENSCH, S. M.; CULLEN, L.; RAIDAL, S. R. Assessment of Liver Function in Galahs (*Eolophus roseicapillus*) After Partial Hepatectomy: A Comparison of Plasma Enzyme Concentrations, Serum Bile Acid Levels, and Galactose Clearance Tests. **Journal of Avian Medicine and Surgery**, v. 14, n. 3, p. 164–171, 2000.

KUNUTSOR, S. K. Gamma-glutamyltransferase—friend or foe within? **Liver International**, v. 36, n. 12, p. 1723–1734, 2016.

LUMEIJ, J. T.; WESTERHOF, I. Blood-chemistry for the diagnosis of hepatobiliary disease in birds - a review. **Veterinary Quarterly**, v. 9, n. 3, p. 255–261, 1987.

LUMEIJ, J. T.; REMPLE, J. D. Plasma urea, creatinine and uric acid concentrations in relation to feeding in peregrine falcons (Falco peregrinus). **Avian Pathology**, v. 20, n. 1, p. 79-83, 1991.

MOHANAPRIYA, T. *et al.* Haemato-biochemical alterations of fractured painted storks (Mycteria leucocephala) due to gale in Koonthankulam bird sanctuary, Tamilnadu. **Journal of Entomology and Zoology Studies**, v. 8, n. 1, p. 1128-1130, 2020.

RAIDAL, S. Laboratory Diagnostics for Birds. *In:* HEATLEY, J. J.; RUSSEL, K. E. (Ed.). **Exotic Animal Laboratory Diagnosis.** Hoboken: Willey-Blackwell, 2020, v. 1, p. 429-436.

RESSEL, L.; HETZEL, U.; RICCI, E. Blunt Force Trauma in Veterinary Forensic Pathology. **Veterinary Pathology**, v. 53, n. 5, p. 941-961, 2016.

RILEY, J.; BARRON, H. Wildlife Emergency and Critical Care. **Veterinary Clinics of North America:** Exotic Animal Practice, v. 19, n. 2, p. 613-626, 2016.

ROZSYPALOVÁ, L. *et al*. Causes of admission and outcomes of white-tailed eagles Haliaeetus albicilla in wildlife rescue centres in the Czech Republic during 2010–2020. **Avian Biology Research**, v. 15, n. 3, p. 125-132, 2022.

SCOPE, A.; SCHWENDENWEIN, I. Laboratory Evaluation of Renal Function in Birds. **Veterinary Clinics of North America:** Exotic Animal Practice, v. 23, n. 1, p. 47-58, 2020.

SITDHIBUTR, R. *et al*. Effects on hematology and blood biochemistry profile of intramuscular meloxicam injection in Brahminy kite and Barn owl. **Journal of Veterinary Science**, v. 24, n. 3, e43, 2023.

TILGAR, V. *et al*. The rate of bone mineralization in birds is directly related to alkaline phosphatase activity. **Physiological and Biochemical Zoology**, v. 81, n. 1, p. 106-111, 2008.

WERNICK, M. B. *et al.* Plasma chemistry reference values in the gyr falcon (Falco rusticolus). **Comparative Clinical Pathology**, v. 23, n. 5, p. 1381-1386, 2014.

WILLIAMS, S. M. *et al*. Improved clinicopathologic assessments of acute liver damage due to trauma in Indian ring-necked parakeets (Psittacula krameri manillensis). **Journal of Avian Medicine and Surgery**, v. 26, n. 2, p. 67-75, 2012.

ZAKARIA, H. M. *et al*. Risk factors and management of different types of biliary injuries in blunt abdominal trauma: single-center retrospective cohort study. **Annals of Medicine and Surgery**, v. 52, p. 36-43, 2020.