**LACTIC ACIDOSIS INDUCED BY MANUAL RESTRAINT FOR HEALTH EVALUATION AND COMPARISON OF TWO POINT-OF-CARE ANALYZERS IN HEALTHY LOGGERHEAD SEA TURTLES (CARETTA CARETTA).** J. of Zoo and Wildlife Medicine, 52(4):1195-1204 (2021). Alissa B. Mones, Erika J. Gruber, Craig A. Harms, Catherine M.F. Lohmann, Kenneth J. Lohmann, Gregory A. Lewbart.

Abstract: Sea turtles are often restrained manually for brief periods during veterinary evaluation and care in rescue, rehabilitation, research, and aquarium settings. Blood gas values and lactate are routinely evaluated during triage of sea turtles, and lactate clearance is of prognostic significance in cold-stunned individuals. Although increases in blood lactate have been associated with muscle exertion, experimental forced submergence, trawl and pound net capture, and general anesthesia, changes in blood lactate associated with short periods of manual restraint have not been evaluated. Venous blood gas and lactate values were tested in 16 juvenile loggerhead sea turtles (Caretta caretta) before and after manual restraint for a 15-min routine veterinary examination. The agreement of blood lactate values between two point-of care analyzers (i-STAT and Lactate Plus) was also compared. Blood pH and bicarbonate (HCO3–) decreased significantly (P < 0.001), and partial pressure of carbon dioxide (pCO2) increased significantly (P < 0.0001) after 15 min. Lactate increased significantly between time points for both analyzers (P < 0.0001). Linear regression analysis showed excellent correlation for lactate measurements obtained on both analyzers (r = 0.998). The mean difference in lactate concentrations between the analyzers was statistically significant, indicating that the methods cannot be used interchangeably (P < 0.0001). Deming regression and Bland-Altman plots identified a slight negative proportional bias for lactate measurement by the Lactate Plus compared with the i-STAT. These results suggest that clinicians should evaluate blood gas values and lactate at the beginning of health evaluations and interpret serial lactate values in sea turtles with caution, because even short periods of manual restraint can induce lactic acidosis and considerably influence these values.

Background:

* Lactic acidosis = increased lactate, decreased pH
* Common causes: tissue hypoxia from hypoperfusion, underlying dz (sepsis, liver, kidney failure), drug/toxin exposure, mitochondrial disease, catecholamine inducedChart, scatter chart

  Description automatically generated

Key Points:

* iSTAT and Lactate Plus are NOT interchangeable
  + Excellent correlation
  + Slight negative proportional bias of lactate measurement by Lactate Plus vs. iSTAT = slope <1.0 (graph dotted line = 1.0)
    - Difference between methods greater with increased concentrations of lactate
* 15-minute PE induced metabolic acidosis and increased lactate
  + Blood lactate increased by 40-fold
  + Blood pH and HCO3- decreased; pCO2 and lactate increased
  + Suspect caused by catecholamine/corticosterone release associated with handling in study
* Blood gas lactate should be evaluated at beginning of handling

**"COCCIDIOSIS IN GREEN TURTLES (CHELONIA MYDAS) IN AUSTRALIA: PATHOGENESIS, SPATIAL AND TEMPORAL DISTRIBUTION, AND CLIMATE-RELATED DETERMINANTS OF DISEASE OUTBREAKS"** J. of Wildlife Diseases, 56(2):359-371 (2020).  Silvia Ban de Gouvea Pedroso, David N. Phalen, Michael Terkildsen, David Blyde, Duane T. March, Anita N. Gordon, Phoebe A. Chapman, Paul C. Mills, Helen Owen, Amber Gillett, Hannah B. Lloyd, Geoffrey A. Ross, Jane Hall, Jennifer Scott, Ellen Ariel, Rongchang Yang, Karrie A. Rose.

Abstract: An epizootic of coccidiosis in free-ranging green turtles (Chelonia mydas) occurred in Australia in 1991 and the parasites were thought to be Caryospora cheloniae. Recurring outbreaks over an increased geographic range followed. We used medical records and temporal and spatial data of turtles diagnosed with coccidiosis between 1991 and 2014 to characterize the disease and factors associated with outbreaks. Most affected animals were subadults or older. Neurologic signs with intralesional cerebral coccidia were observed. Coccidia associated with inflammation and necrosis were predominantly found in the intestine, brain, kidney, and thyroid. Cases occurred in the spring and summer. Three major outbreaks (1991, 2002, and 2014) were concentrated in Port Stephens, New South Wales (NSW) and Moreton Bay, Queensland, but cases occurred as far south as Sydney, NSW. Coccidiosis cases were more likely during, or 1 mo prior to, El Niño–like events. Molecular characterization of the 18S rRNA locus of coccidia from tissues of 10 green turtles collected in 2002 and 2004 in Port Stevens and Sydney imply that they were Schellackia-like organisms. Two genotypes were identified. The Genotype 3 sequence was most common (in eight of 10 turtles), with 98.8% similarity to the 18S sequence of Schellackia orientalis. The Genotype 4 sequence was less common (in two of 10 turtles) with 99.7% similarity to the 18S sequence of the most common genotype (Genotype 1) detected in turtles from the 2014 Moreton Bay outbreak. Our study will help with the identification and management of future outbreaks and provide tools for identification of additional disease patterns in green turtles.

Key Points:

* Signalment and signs: 64 green turtles with coccidiosis
  + Most clinical (61/63), most died (54/63), few released (6/63)
    - **Prognosis for clinically ill turtles with coccidia = grave**
  + Moderately depressed/moribound > unilateral head tilt, circling > emaciation, diarrhea
  + Fatal coccidiosis occurred with higher prevalence in large subadults
* Coccidia distribution/lesions:
  + **Predominately in intestine and brain** (and kidney, thyroid) - inflammation and necrosis
  + GIT - wide range from mild inflammation to fibrinous erosive and ulcerative enteritis with plaques; all parts of intestine could be affected
    - Some lesions in GIT with absences of coccidia - does not exclude infection
  + Brain (systemic coccidiosis) - miliary white foci grossly; range of mild to severe perivascular nonsuppurative to granulomatous inflammation of brain and meninges
  + Parasite diagnosis: fecal float, wet prep, GIT mucosal scrape, histopath, PCR
* Temporal and geo distribution:
  + **Cases were seasonal - spring and summer; should be suspected in stranded turtles Sep-Feb and peaking in October**
  + Disease occurrence has wider (but still discrete) geo distribution than originally described
    - Diseases were concentrated/clustered
  + **Outbreaks more likely to be during or 1 month prior to El Nino-like events**
    - El Nino event = a condition that occurs when surface water in the equatorial Pacific becomes warmer than average and east winds blow weaker than normal
    - No association with rain fall, atmospheric temp, sea surface temp
* Molecular characterization - **two 18s RNA genotypes identified**
  + Molecular characterization from tissues (n=10) imply Schellackia-like organisms
  + Genotype 3 sequence (most common) 99% similar to Schellackia orientalis
    - Schellackia = parasite of Asian grass lizard
  + Genotype 4 sequence (less common) with 99.7% similarity to a genotype 1 (2014 outbreak)
  + Both had similar tissue distribution and disease pattern, and there was reasonable correlation between tissues that were histologically positive and PCR results

*J Zoo Wildl Med*. 2021;52(2):610-617

[**BLOOD FATTY ACID PROFILES OF NERITIC JUVENILE WILD GREEN TURTLES (*CHELONIA MYDAS*) AND KEMP’S RIDLEYS (*LEPIDOCHELYS KEMPII*)**](https://doi.org/10.1638/2019-0173)

Koutsos EA, Minter LJ, Ange-Van Heugten KD, Mejia-Fava JC, Harms CA

**ABSTRACT:** Blood fatty acid profiles can indicate an animal’s wild-type diet composition and fatty acid status, but have not been reported in sea turtles. Newer technologies allow for fatty acid profiles from very small (less than three drops) samples of whole blood. This study examined whole blood fatty acid profiles of presumably healthy, neritic, juvenile, wild green (*Chelonia mydas*) (n = 9; 6 males, 3 females) and Kemp’s ridley (*Lepidochelys kempii*) (n = 8; 6 males, 2 females) turtles from North Carolina, USA. Saturated fatty acids, which can be synthesized de novo, consisted primarily of 16:0, although green turtle blood had a higher proportion of 18:0 (P < 0.001) than Kemp’s ridleys, while Kemp’s ridley blood had higher proportions of 17:0 (P = 0.007), 20:0 (P = 0.03), 22:0 (P = 0.002), and 24:0 (P < 0.001) as compared with green turtles. Total monounsaturated w7 fatty acids, which can be synthesized de novo or may be diet derived, were higher in Kemp’s ridleys and predominantly in the form of 16:1 and 18:1w7 fatty acids. Kemp’s ridley blood had more than double the relative proportion of 16:1w7 as compared with green turtles (P = 0.03). Green turtles had higher levels of 18:2w6 than Kemp’s ridleys (P = 0.02). In both turtle species, 20:4w6 was detected, despite predicted low dietary proportions, suggesting bioconversion from precursors. Finally, green turtles had higher levels of 18:3w3 compared with Kemp’s ridleys, while Kemp’s ridleys had higher proportions of 20:5w3 compared with green turtles (P < 0.001, = 0.007, respectively). Whole blood fatty acid profiles generally correlate to previous work with lipid depots, supporting the use of this less invasive methodology to advance the understanding of fatty acid nutrition of sea turtles. These data can be used to assess and guide nutrition and health programs for sea turtles under human care

**Background:**

* CMs exhibit a shift in dietary feeding strategies over their lifetime
  + Pelagic juvenile CMs are carnivorous, feeding on crustaceans, jellyfish, and ctenophores
  + When move to inshore waters -> become primarily herbivorous (seagrasses & algae)
    - In Caribbean/southern Atlantic, main food = turtle grass (*Thalassia testudinum*)
    - Further north in the Atlantic Ocean, *Thalassia* not available
      * Food items included *Halodule wrightii* and *Zostera marina* seagrasses
* LKs are carnivorous throughout their life, feeding on crabs and other invertebrates
* Traditionally, the measure of FA status was via lipid depot samples
  + Newer methods can provide long-term FA status in one drop of whole blood
  + Whole blood provides more accurate long-term FA status vs. plasma or serum
    - Whole blood FA status reflects the time of erythropoiesis
  + The long lifespan of sea turtle RBCs (600–800 days) may result in whole blood FA profiles reflecting longer periods of time
* Saturated FA considered non-essential in the diet of animals
* In LKs, blood (this study) and lipid depot FA were similar
  + Reflective of similar geographical regions and overlapping diets
  + Corresponded w/ blue crab meat FA profile (primary LK diet item in the NW Atlantic)
* Linoleic acid considered an essential FA for vertebrates due to inability to synthesize de novo
  + Higher levels of linoleic acid in CMs likely reflects the high level of this FA in seagrasses
* Obligate carnivores lack capacity to convert linoleic acid to arachidonic acid, thus arachidonic acid is also considered essential in terrestrial obligate mammalian carnivores
  + Both turtle species had equivalent levels of arachidonic acid suggesting that both species of sea turtles can synthesize arachidonic acid from precursors (linoleic acid)
* The reduction in margaric acid in CMs corresponding w/ increasing SCL may reflect shift from carnivory to herbivory that is occurring when they move inshore
  + This hypothesis is supported by the significantly higher proportion of margaric acid in carnivorous LKs in this study, which increased with increasing SCL

**TLDR:**

* Green turtles generally have higher levels of linoleic acid reflecting their more herbivorous diet at this life stage
* Kemp’s ridleys had higher levels of omega-7 FA and the omega-3 PUFA EPA reflecting their more carnivorous diet
* The presence of arachidonic acid in both species suggests adequate capacity of these animals to synthesize this FA de novo

**Related Articles**

Dass K, Koutsos E, Minter LJ, Ange-van Heugten K. Analysis of fatty acid profiles in eastern box (*Terrapene Carolina Carolina*) and common snapping (*Chelydra serpentine*) turtles for in wild and managed care environments. *J Zoo Wildl Med*. 2020; 51(3):478–484

*JWD* 2021 57(4):761-772

[**Evaluation Of Immune Function In Two Populations Of Green Sea Turtles (Chelonia Mydas) In A Degraded Versus A Nondegraded Habitat**](https://doi.org/10.7589/jwd-d-20-00204)

Sposato P, Keating P, Lutz PL, Milton SL

**ABSTRACT:** There is a strong correlation between degraded marine habitats and the prevalence of diseases such as green turtle fibropapillomatosis (GTFP) in coastal populations. In GTFP, small to large tumors grow on the turtle's soft tissues and shell, while internal nodules may also occur. The disease primarily affects juvenile green sea turtles (*Chelonia mydas*) that reside in nearshore waters. As a link has been shown between environmental pollution and immune suppression in a variety of animals, the objective of our research was to compare innate and adaptive immune responsiveness in green sea turtles from a severely degraded and a more pristine habitat, which differ greatly in rates of GTFP. We quantified phagocytosis by flow cytometry and performed in vitro stimulation analysis to measure activity of both the innate and adaptive immune systems in wild-caught Florida green turtles. Sea turtles from the degraded environment, both with and without visible cutaneous tumors, exhibited significantly reduced phagocytosis and stimulation indices than did those from the less polluted environment. Our results suggest that environmental factors may contribute to the development of GTFP and thus can impact the health of sea turtle populations.

**Key Points:**

* Chelonid alphaherpesvirus 5 (ChHV5) most likely etiologic agent for FP
  + FP spread/pathogenesis involves interactions between the virus, host, and environment
* Study compared immune function in two wild green sea turtle populations in Florida:
  + Indian River Lagoon (polluted estuary)
  + Trident Basin (Cape Canaveral, more pristine)
* Phagocytosis assay: incubated cells with fluorescein labeled beads
  + Evaluated % of cells containing phagocytosed beads with flow cytometry
* Lymphocyte proliferation assay to assess B and T cell activity (adaptive immunity)
* Both groups: heterophils largest leukocyte fraction
  + No significant difference in circulating heterophil percentages between populations
  + Monocytes higher in Indian River Lagoon turtles, no other significant WBC differences
* Phagocytosis higher in heterophils from Trident Basin turtles
  + Within Indian River Lagoon population, activity higher in animals without tumors
  + Tumor positive animals had the lowest % of phagocytosis regardless of season
  + Other studies have shown impacts by pollutants like HABs and heavy metals on immune function (manatees, turtles, pinnipeds)
* Discrepancies in literature regarding which cells predominate phagocytosis in sea turtles
  + Monocytes in loggerheads in one study, lymphocyte and monocytes in others
* Trident Basin turtles exhibited highest stimulation indices reflective of adaptive immune activity
  + Both B & T lymphocytes from Indian River Lagoon turtles w/ FP were unresponsive

**TLDR:** Both adaptive and innate immune function compromised in green turtles in a highly polluted Indian River Lagoon. Lower function in turtles with FP too.

**Related Articles:** *None on the current ACZM reading list*

ASSESSMENT OF RESIDUAL VASCULARIZATION OF THE LIMB AS A PROGNOSTIC FACTOR TO AVOID SEA TURTLE FLIPPER AMPUTATION

Delia Franchini,1 Carmela Valastro,1 Stefano Ciccarelli,1,4 Mario Ricciardi,2 Diana Lenoci,3 Marialaura Corrente,1 and Antonio Di Bello1

ABSTRACT: Entanglement occurs when a marine turtle becomes trapped within anthropogenic materials such as debris or fishery gear, inducing strangulation of anatomical parts such as flippers or the neck, causing deep lacerations, maiming, amputation, or choking. Often, severely entangled flippers in captured or stranded turtles are removed surgically. Turtles with flipper impairment have difficulty in swimming, diving, and feeding. Our aim was to use color Doppler ultrasound and multi-detector computer tomography to evaluate residual vascularization or neovascularization in severely entangled flippers of loggerhead sea turtles (Caretta caretta) to assess viability of flippers, even in the absence of limb sensation. We studied 12 turtles with either unilateral (n1⁄48) or bilateral (n1⁄44) involvement. A total of 14 flippers were severely entangled and two flippers were spontaneously amputated. Only two of the 14 entangled flippers had to be removed surgically. For 12 entangled flippers, after surgical curettage, the treatment protocol was based on the use of a plant-derived commercial dressing. The animals were monitored and treated for 1–3 mo, until the soft tissue defects were completely healed by secondary intention. Interestingly, in the treated animals the healing flippers steadily recovered motility and sensation, restoring the complete functionality of the flipper. Vascularization of the limb was found to be critical to prevent amputation of entangled flippers, preserving the flipper and its functionality with conservative therapy and avoiding amputation as much as possible. Our study showed that in cases of entanglement, amputation does not need to be performed immediately but can wait for nonviability to declare itself following conservative therapy and should be reserved as a last-resort treatment.

* Fishery gear- monofilament- most significant source of entanglements
* If not addressed areas of constriction can cause deep lacerations, fractures, bone loss/exposure, secondary infections, and osteomyelitis
* Sea turtles retain swimming and maneuvering after the loss of one flipper (but swimming and diving are affected; eating and repro behaviors also affected)
* Forelimb loss in males or hindlimb loss in females= negative impact reproductively
* Color doppler ultrasound was used and multi detector computer tomography to evaluate residual vascularization or neovascularization in entangled flippers
* Evaluated overall health and then function and neurologic exam of the entangled flipper (withdrawal and deep pain)
* For MDCT turtles underwent anesthesia and contrast was administered to assess the vascularization of the flipper
* If total absence of vascularization= amputation; if residual presence= surgical curettage and daily treatment
* Most of the turtles had front flipper entanglements
* Humeral fractures with severe bone loss was present in most flippers
* In 11 of the flippers the brachial and radial artery was clearly visible on CDDU
* Two had sonographic findings of linear foreign body= suggesting ingested line
* 5 had MDCT- showed bone damage in middle aspect of humeral diaphysis: ranged from incomplete to multi-fragmented, complete
* MDCT angiography showed main trunk interruption of brachial artery BUT the two halves were connected by tortuous collaterals
* 10 turtles with residual vascularization underwent treatment to save flipper
  + Flippers slowly regained almost complete motility and sensation
  + All soft tissue injuries healed by second intention
* 7 species of bacteria were IDed (gram negative): such as Pseudomonas puterefaciens
  + All were resistant to beta lactams
* 10/12 turtles were juveniles, the other two were subadult= confirming young animals are more prone to entanglement
* Turtles with forelimb issues= greater likelihood of stranding
* All flippers showed absent neurologic signs on initial PE (deep pin and withdrawal)
  + All had progressive recovery after complete healing of soft tissues

Key Points:

* In conservative therapy- all had neovascularization proven by follow up imaging after 1 month of therapy
* All flippers gradually recovered almost complete sensation in 3-5 mo
* CDU is a great approach to evaluation vascularization status of the brachial artery and axillary vein
* Coelomic U/S is useful for full evaluation of turtle GI to find linear FB that were not able to be seen by rads
* MDCT angiography showed two patterns of collateral circulation: deep, large collaterals (peri-humeral course) and small, thin collaterals (superficial/subcutaneous)
* Plant-derived dressing IPWD showed marked promotion of wound healing in mammals and sea turtles- it also prevented secondary infections (FA’s?) without needing secondary antibiotics
* Long bone fractures may not impair the flipper function long term- as these are not meant to support body weight (like terrestrial species)
* Despite presence of fracture= all with conservative management had normal mobility of flipper after 1-3 months
* UNLIKE MAMMALS- absence of sensation and deep pain does not mean amputation

SPINAL ANESTHESIA IN GREEN SEA TURTLES (CHELONIA MYDAS) UNDERGOING SURGICAL REMOVAL OF CUTANEOUS FIBROPAPILLOMAS

Fabio Futema, DVM, PhD, Fernanda Maria de Carvalho, DVM, PhD, and Max Rondon Werneck, DVM, PhD

Abstract: Techniques for anesthesia of green sea turtles (Chelonia mydas) are required for medical treatment. The use of spinal anesthesia has been reported in a few species of turtles for different purposes. The objective of this study was to evaluate the use of 2% lidocaine for spinal anesthesia of green sea turtles undergoing surgical removal of cutaneous fibropapillomas. Ten free-ranging green turtles presenting with cutaneous fibropapillomas

were included in the study. Animals were accidentally captured or rescued by local fishermen and brought to the Ubatuba Research Base (Sao Paulo, Brazil) of the Brazilian Sea Turtle Conservation Program for rehabilitation. Animals were administered 2% lidocaine (0.2 ml/10 cm of carapace) in the epidural/subarachnoid space of the tail and monitored throughout surgery. The technique was effective for all animals, with fast onset of motor and sensory blockade (3 6 1.76 min) and relatively fast recovery time (83.9 6 16.2 min). Fibropapillomas were removed from all animals with no signs of pain (i.e., no behavioral response during surgical procedure, such as head and forelimb movement, showing discomfort) and they were all rehabilitated and successfully returned to their natural habitat. The technique was considered effective, safe, and affordable for use on green turtles undergoing surgical removal of cutaneous fibropapillomas.

* Reptiles have an underdeveloped epidural space because of dorsoventral flattening of the caudal vertebrae
* Marine turtle fibropapillomatosis is infectious that affects all hard shelled species of marine turtles- frequently seen in greens
  + Associated with alphaherpesvirus; “chelonid fibropapilloma-associated herpesvirus”
* Dorsal recumbency, tail pulled ventrally- two imaginary perpendicular lines were drawn one at the midline and the other at the most proximal intervertebral space of the tail located on palpation
* Used lidocaine without vasoconstrictor (dose of 0.2 ml/10 cm straight carapace length)
  + Administered if negative pressure with no blood or CSF: however, you wont always get CSF in the subarachnoid space
* Six variables were evaluated:
  + Time for performing the anesthesia technique
  + Onset of motor blockade
  + Onset of sensory blockade
  + Motor recovery of tail
  + Partial recovery of hindlimb mobility
  + Total recovery of hindlimb mobility
* Surgery began at onset of motor and sensory blockade
* Blockade was effective in all animals- surgical procedure was able to be completed with no signs of pain (behavioral, high heart rate)
* No signs of anesthetic toxicity: i.e. loss of consciousness, seizures, cardiotoxicity (cardiac arrest)
* Animals also had normal motor and sensory response of forelimbs throughout the entire procedure- block did not reach brachial plexus
* Anesthesia of the caudal neuraxis by peridural application of lidocaine was effective for all animals
* Onset and recovery time was faster than compared with inhalant anesthesia
* Deep anesthesia was longer compared to injectable ketamine
* turtles= sensory and motor blockade occur simultaneously (combined into one variable)

Comparison of Oxytetracycline Pharmacokinetics After Multiple Subcutaneous Injections in Three Sea Turtle Species.

Innis, C., Kennedy, A., Wocial, J., Burgess, E., & Papich, M. G.

*Journal of Herpetological Medicine and Surgery*, 2020;30(3):142-147.

Oxytetracycline (42 mg/kg SC q6d) was injected into the dorsal shoulder region of 29 sea turtles during clinical management after stranding, including 10 Kemp's ridley (*Lepidochelys kempii*), 10 loggerhead (*Caretta caretta*), and nine green sea turtles (*Chelonia mydas*). Before injection, the drug was diluted into a suitable fluid for injection (5–20 ml/kg) as chosen by the attending veterinarian. Turtles were treated for as long as clinically indicated prior to discontinuing the drug (range 2–10 doses, median four). After the final injection, blood was collected at 1, 2, 4, 8, 72, 144, and 288 h and plasma harvested for measurement of the oxytetracycline plasma concentration. To limit the volume of blood collected, a sparse sampling strategy was used with samples collected at only three or four time points per turtle. The plasma oxytetracycline concentration was measured with high pressure liquid chromatography. Population pharmacokinetics using nonlinear mixed effects modeling produced the following results: half-life, 36 h; volume of distribution, 0.78 L/kg; and area-under-the-curve, 2,799 µg\*h/ml. Using this dose and method of administration, the plasma oxytetracycline concentrations were maintained above a minimum inhibitory concentration value of approximately 4 µg/ml for approximately 6 days.

Key Points

* Oxytetracycline – Activity against many gram positive and some gram negatives.
  + Useful for tx of Nocardia, Mycoplasma, Rickettsiae, Chlamydia/Chamydophila infections.
  + Used as a bone marker in sea turtles for skeletochronology studies.
  + Single dose PK studies IV and IM in loggerheads show good systemic availability for the IM route and long elimination times > 60 h by both routes.
* This study:
  + Oxytet rapidly absorbed and well tolerated SQ in these sea turtles.
  + Max plasma concentration at approximately 1-2 hours of delivery.
  + Results suggest a longer dosing interval than which was suggested by previous single dose studies.
  + Oxytetracycline at 42 mg/kg SQ Q6d in Kemps, loggerheads, and green sea turtles appears safe and provides plasma concs greater than a value of 4 mcg/ml for approximately 6 days.

References

Harms CA, Papich MG, Stamper MA, Ross PM, Rodriguez MX, Hohn AA. Pharmacokinetics of oxytetracycline in loggerhead sea turtles (*Caretta caretta*) after single intravenous and intramuscular injections. Journal of Zoo and Wildlife Medicine. 2004 Dec 1:477-88.

PHARMACOKINETIC BEHAVIOR OF MELOXICAM IN LOGGERHEAD (*CARETTA CARETTA*), KEMP’S RIDLEY (*LEPIDOCHELYS KEMPII*), AND GREEN (*CHELONIA MYDAS*) SEA TURTLES AFTER SUBCUTANEOUS ADMINISTRATION

Norton TM, Clauss T, Sommer R, Stowell S, Kaylor M, Thistle C, Cox S.

Journal of Zoo and Wildlife Medicine 2021;52(1):295–299

The objective of this study was to determine the pharmacokinetics of a single dose of meloxicam administered subcutaneously (SQ) to three species of sea turtles: loggerheads (*Caretta caretta*), Kemp’s ridley (*Lepidochelys kempii*), and greens (*Chelonia mydas*). A dose of 1 mg/kg was given to the Kemp’s ridleys and greens, whereas the loggerheads received 2 mg/kg. After SQ administration, the half-life (t1/2) of meloxicam administered at 1 mg/kg in the Kemp’s ridleys was 5.51 hr but could not be determined in the greens. The half-life of meloxicam administered at 2 mg/kg in the loggerheads was 2.99 hr. The maximum concentration (Cmax) for meloxicam after SQ administration at 1 mg/kg in the Kemp’s ridleys was 6.76 lg/ml and in the greens was 9.35 lg/ml. The Cmax in loggerheads for meloxicam after SQ administration at 2 mg/kg was 3.63 lg/mL. Meloxicam administered SQ at a dose of 1 mg/kg to the Kemp’s ridley and greens provided measurable plasma concentrations of meloxicam for 48 and 120 hr, respectively, with no adverse side effects. In loggerheads, meloxicam administered SQ at a dose of 2 mg/kg provided measurable plasma levels of meloxicam for only 24 hr. Plasma levels of meloxicam of greater than 0.5 lg/ml are considered to be therapeutic in humans. Results suggested that administration of meloxicam SQ at 1 mg/kg in Kemp’s ridleys and greens would result in plasma concentrations greater than 0.5 lg/ml for 12 and 120 hr, respectively. The administration of 2 mg/kg meloxicam to loggerhead turtles resulted in plasma concentrations greater than 0.5 lg/ml for only 4 hr.

KEY POINTS:

* Half-life could not be determined in greens b/c elimination phase was not complete even after extending collection times from 72 to 120 hr.
* Completely different PK for each of the 3 sp. used in this study
* Highlights performing PK studies for a drug in each species, and not extrapolating across “all sea turtles”
* Differences in diet (carnivores vs herbivores), vs hindgut fermentation or not, size, metabolism, sex

Take home:

* The pharmacokinetics of Meloxicam in Loggerhead, Kemp’s Ridley and Green sea turtles after SQ administration are all different.
* Therapeutic drug levels of Meloxicam were reached for 12 hrs in Kemp’s Ridley sea turtles, and 120 hrs in Green sea turtles after 1mgkg SQ. Therapeutic drug levels were ONLY reached for 4 hr after SQ dosing of 2mg/kg in Loggerhead sea turtles.
* Drug dose extrapolation should be used cautiously in species where PK has not been performed.

\*[Plasma Biochemistry and Hematologic Values of Cold-Stunned Loggerhead Sea Turtles (*Caretta caretta*)](https://bioone.org/journals/journal-of-herpetological-medicine-and-surgery/volume-30/issue-2/19-08-209.1/Plasma-Biochemistry-and-Hematologic-Values-of-Cold-Stunned-Loggerhead-Sea/10.5818/19-08-209.1.full) Kerry L. McNally, Charles J. Innis Journal of Herpetological Medicine and Surgery 30 (2), 88-95, (11 June 2020) <https://doi.org/10.5818/19-08-209.1>

**Abstract**: Cold-stunned loggerhead sea turtles (*Caretta caretta*) strand annually in the northeastern United States and are admitted to rehabilitation facilities when rescued alive. Hematologic and plasma biochemical data were retrospectively evaluated from 133 cold-stunned loggerhead turtles that were admitted for rehabilitation between 2008 and 2016. Convalescent data were compared with initial data for 24 turtles for which paired data were available. **Convalescent values for white blood cell count, heterophil count creatine kinase, lactate dehydrogenase, glucose, and uric acid were significantly lower than initial values, whereas convalescent eosinophil count, alanine aminotransferase, aspartate aminotransferase, albumin, gamma-glutamyl transferase, total protein, globulin, blood urea nitrogen, calcium, phosphorus, chloride, and potassium were significantly higher.** *Results indicate that cold-stunned loggerhead turtles may be affected by dehydration, reduced renal function, cellular injury, deranged metabolic status, and activation of the adrenocortical stress response.* Specific derangements associated with mortality could not be statistically characterized because only four turtles died.

Key Points:

* Cold stunning events occur when turtles do not migrate south before temps drop
* Sequelae include cardiorespiratory depression, dehydration, reduced renal function, pneumonia, sepsis, osteomyelitis, and death
* Most cold stunned turtles have mild physiologic derangements
* Leukocytosis, heterophilia, lymphopenia (increased H:L ratio), eosinopenia likely due to stress leukogram (elevated corticosterone documented in Kemp’s ridleys that are cold-stunned)
* Lower after stay in rehab – WBC, heterophils, CK, LDH, glucose, UA
* Higher after stay in rehab – Eosinophils, ALT, AST, Alb, GGT, TP, Glob, BUN, Ca, Phos, Cl, K
* Severe hypernatremia & hyperkalemia was seen in CS KR but these loggerheads trended towards hypokalemia
* Most severe cases – hematocrit, ALT, AST, CK, Phos, K, UA were severely elevated in the ones that died

Take home: Most CS turtles have mild changes in their leukogram and chemistries.  But severe derangements may indicate prognosis

\*Powell, Ashley L., et al. "Osteomyelitis in cold-stunned Kemp's ridley sea turtles (Lepidochelys kempii) hospitalized for rehabilitation: 25 cases (2008–2018)." *Journal of the American Veterinary Medical Association* 259.10 (2021): 1206-1216.

Abstract: OBJECTIVE To characterize osteolytic lesions in cold-stunned Kemp’s ridley sea turtles (Lepidochelys kempii) hospitalized for rehabilitation and describe methods used for the management of such lesions. ANIMALS 25 stranded, cold-stunned Kemp’s ridley sea turtles hospitalized between 2008 and 2018. PROCEDURES Medical records of sea turtles with a diagnosis of osteolytic lesions were reviewed retrospectively to obtain the date of diagnosis, clinical signs, radiographic findings, microbial culture results, hematologic and plasma biochemical data, cytologic and histologic findings, antimicrobial history, time to first negative culture result, treatment duration, and outcome. RESULTS Lesions were identified radiographically a median of 50 days after admission and were located within epiphyses or metaphyses of various appendicular joints. Lesions were associated with periarticular swelling (n = 24), lameness (16), lethargy (2), and hyporexia (2). Bacterial culture yielded growth of single organisms (n = 16), multiple organisms (2), or no growth (6). Significant differences in hematologic and biochemical data were detected between the times of diagnosis and convalescence. Cytologic and histologic findings characterized the lesions as osteomyelitis leading to septic arthritis. Sixteen sea turtles were managed medically, and 8 were managed medically and surgically. Surgery resulted in rapid improvement in joint mobility and overall clinical status. Most (22/25 [88%]) sea turtles survived and were released after long-term management. CONCLUSIONS AND CLINICAL RELEVANCE During rehabilitation, cold-stunned Kemp’s ridley sea turtles may be affected by osteomyelitis. Medical management based on antimicrobial susceptibility testing was effective for most turtles. Long term management efforts in turtles are justified by high survival rate.

Summary:

* Intro
  + Cold stunned kemps ridley sea turtles
    - Common derangements: marked hypercapnia, hypoxemia, acidemia, and hyperkalemia
    - Common sequelae: bacterial and fungal pneumonia, chronic renal failure, sepsis, and osteomyelitis
    - Treatment: gradually warmed to 24-25 °C over several days, treated for dehydration, cardiorespiratory depression, metabolic derangements, concurrent pathology
    - Often radiographic osteolytic lesions of appendicular joints, including shoulder, elbow, hip, carpal, and tarsal joints
      * Lytic phalange lesions fairly common but appear to be transient
* M+M:
  + Retrospective of 25 cold stunned kemps ridley sea turtles
  + Objective: characterize osteolytic lesions by utilizing several interrelated diagnostic modalities and to describe methods of medical and surgical management
* Results/Discussion:
  + osteolytic lesions detected in ~1% of cold-stunned Kemp’s ridley sea turtles that were hospitalized over an 11-year period
    - most lesions associated with bacterial osteomyelitis
  + Common CS:  periarticular swelling (n=24), lameness (n=16), lethargy, and hyporexia
  + Initial radiographic lesions observed after median of 50 days of hospitalization
  + Early-stage osteolytic lesions restricted to epiphysis and metaphysis of long bones
    - lesions - focal radiolucent region of geographic to moth-eaten lysis
    - CT provided no advantages over rads for assessment of these lesions
  + Joint aspirates for C/S: most single bacterial isolation but some mixed
    - Enterococcus spp (n = 10), Serratia marcescens (7), Citrobacter braakii (1), Acinetobacter haemolyticus (1), Escherichia coli (1), Morganella morganii (1), Mycobacterium chelonae (1), Pseudomonas sp (1), and Vibrio alginolyticus (1)
    - Serratia spp - opportunistic pathogens associated with septicemic cutaneous ulcer disease in freshwater chelonians, possibly normal oral flora in green sea turtles
  + Blood culture:
    - 11 turtles -  single bacterial species → E faecalis, Enterococcus spp, S marcescens
      * 8 turtles results corresponded with C/S for osteolytic site
  + Negative cultures not uncommon
  + 60% turtles received ceftazidime on admission as initial prophylaxis
    - 9/10 turtle with Enterococcus spp received ceftazidime as initial prophylaxis
  + 40% turtles received oxytetracycline as initial prophylaxis
    - all 8 turtles with S marcescens received oxytetracycline as initial prophylaxis
  + 5 turtles underwent arthrotomy of 1 joint (shoulder or carpal joint), 3 turtles had arthrotomy in multiple joints (unilateral shoulder and bilateral elbows, bilateral shoulders, or unilateral elbow and knees)
    - affected joints contained compacted caseous material and sequestra
  + CBC/chem at the time of radiographic diagnosis compared to convalescent samples:
    - higher WBC, absolute heterophil, absolute and relative monocyte, absolute and relative basophil, and relative eosinophil counts; plasma chloride and cholesterol; and ALP
    - Lower albumin, total protein, phosphorus, and potassium
  + 88% sea turtles released, 3 died or euthanized
    - Median hospitalization - 256 days
    - average hospitalization after initial diagnosis -213 days of hospitalization
  + initial or empirical antimicrobial prophylaxis or NSAID was ineffective for most turtles
    - more specific treatment based on C/S was often successful
  + surgical management/debridement often successful when medical management failed
  + Common complications - pneumonia, sepsis, or gastroenteritis
  + Suspected cause of joint lesions - immunosuppression and bacteremia or fungemia vs ischemic necrosis from hypothermia
    - Most cases here septic with concurrent positive blood culture

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