THE UNIVERSITY OF SYDNEY
Centre for Veterinary Education

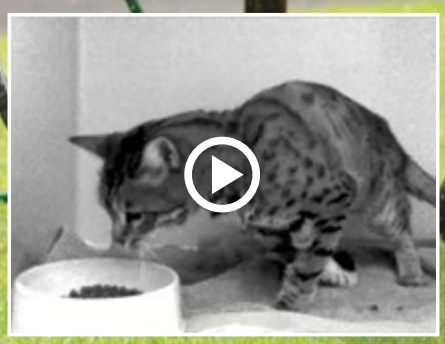
C&T
CONTROL AND THERAPY SERIES

MARCH 2014 ISSUE 274
Australia's Leading Veterinary Forum

EXERTIONAL HEAT ILLNESS IN THOROUGHBRED RACEHORSES: OBSERVATIONS AND TREATMENT IN THE FIELD

by Meg Brownlow p. 13

GOAT ARTICLE COURTESY OF SANDRA BAXENDELL



VIEW THE FILM CLIP –
LOCALISED TETANUS IN A BENGAL CAT

VALE
PAUL GOTIS-GRAHAM

C&T

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CONTENTS

FROM THE DIRECTOR

Welcome to the first edition of C&T for 2014. You may notice some changes in style and layout of this edition as our new marketing team has worked hard to provide a fresh appearance to enhance the fantastic content from our contributors.

Lis Churchward and Richard Malik continue as the main editors, while the design and layout have been transformed by our new marketing manager Ines Borovic and design officer Monique Coffey. I think they have done a great job working under pressure to meet our production deadlines and should be congratulated on their results.

As is often the case with C&T, we have a mixture of articles across a broad range of species, from macropods to horses and goats, to dogs and cats. Many of these articles are quite extensive and we appreciate the time and effort it takes to produce articles of such high quality, often supported by great photos and video clips, which are accessible by viewing the ebook version of the C&T.

This edition has really made me reflect once again on the wonderful diversity that a veterinary career provides and while the issue of oversupply of veterinary graduates is often debated, there is often not sufficient consideration given to the many options conferred by a veterinary degree. So many new graduates seem set on a career in what they see as traditional small animal practice, yet their education has equipped them with the tools to pursue whatever path they choose. Tom Hungerford's words about the goanna track to success are frequently reproduced in C&T and many of our articles reflect the diversity in career paths followed by members of the profession.

As mentioned in the obituary for Alan Warner in the last C&T, the last article he wrote for C&T appears in this issue on page 10. Al was a prolific contributor of articles for C&T over many years and he will be greatly missed by his friends and colleagues.

We were also greatly saddened by the death of another ardent CVE supporter, Paul Gotis-Graham, in January. Paul was on the CVE Council for many years and more recently had been a member of a review panel and management committee for the CVE. His obituary, which appears on page 5, is a moving tribute to a dedicated veterinarian who bravely fought leukaemia for a number of years, yet never stopped giving his all to his wife Kate, his many friends and the profession.

I am sure that we can all draw inspiration from others, who put themselves out to write articles and contribute to the profession in order to ensure we continually improve our knowledge and challenge existing beliefs, as a part of our journey of life-long learning.

CALENDAR
CVE SHORT COURSES

2014

From surgery to rehabilitation, the CVE has a wide range of conferences, seminars, workshops and online courses you can choose from.

The CVE **conferences** and **workshops** offer highly intensive learning providing you with a large hit of CPD points in a short time. Our 1-2 day **seminars** are a practical way to receive a thorough update or refresher. The **TimeOnline** courses are delivered wholly online, giving you the flexibility to study when and where you wish and complete your course at your own pace.

CONFERENCES & SEMINARS

16 Mar	Dermatology	**Hobart**
10 - 11 Apr	Feline Tales	**Melbourne**
4 May	Small Animal Dentistry	**Adelaide**
1 Jun	Dermatology	**Canberra**
16 - 19 Jun	Cradle to Grave - Small Animal Health and Wellbeing Conference	**Melbourne**
29 Jun	ecoCPD: Radiology	**Adelaide**
15 - 18 Sep	Canine and Feline Internal Medicine Conference	**Hawaii, USA**
19 Oct	Small Animal Dentistry	Port Macquarie

WORKSHOPS

29/30 Mar	Basic Echocardiography	**Sydney**
19 Jul	Hip & Stifle	**Sydney**
20 Jul	Bone Plating	**Sydney**
9 Aug	Feline Surgery	**Sydney**
10 Aug	Canine Surgery	**Sydney**
16 Aug	Feline Surgery	**QLD**
17 Aug	Canine Surgery	**QLD**
26 Sep	Basic Echocardiography	**Melbourne**
27 Sep	Advanced Echocardiography*	**Melbourne**
8/9 Nov	Basic Echocardiography	**Cairns**

* Prior learning will be required to attend this workshop.

For more information or to register for any of our Conferences, Seminars or Workshops please visit the Events page of the CVE website, ***www.cve.edu.au/events***

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Become a member of CVE to receive 20% off all CVE run conferences, seminars and TimeOnline courses. The CVE also runs a series of professional development **webinars** throughout the year. Our **webinars** are free to CVE members, while non-members can attend for $50.00 per webinar.

All CVE courses are presented by leading experts in their field, so you can confidently choose the CVE to provide you with the quality professional development you seek to become a better practitioner and ensure the continuing success of your practice.

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24 Mar	Respiratory Physiology, Monitoring and Basic Support
14 Apr	Otitis in Small Animals
28 Apr	Rabbits and Rodents
5 May	Dentistry Diagnosis to Dollar
19 May	Avian
9 Jun	Respiratory Failure and Ventilation
16 Jun	Marine Wildlife
30 Jun	Practical & Advanced Dentistry
7 Jul	NEW Feline Emergency Medicine
28 Jul	Anaesthetic Complications

TimeOnline

For more TimeOnline courses and further information visit: ***www.cve.edu.au/timeonline***

Visit our website (www.cve.edu.au) to find out more about our programs or you can register your interest by emailing us at *cve.events@sydney.edu.au*

Dates for CVE short courses are subject to change, Please refer to the CVE website ***www.cve.edu.au*** for the latest updates.

SAVE THE DATE OR REGISTER NOW!

WEBINARS

27 Mar	Kittens, Early desexing and behavioural issues affecting young cats
24 Apr	Aggression in dogs & cats
22 May	Backyard Chooks Part 2
5 Jun	Pancreatitis in cats
26 Jun	IMHA and how to prevent pulmonary thromboembolism
24 Jul	Tick paralysis treatment update
7 Aug	Blue tongues, turtles and frogs
21 Aug	Management of CHF in dogs with mitral valve disease
11 Sep	Rabbit medicine and dentistry
25 Sep	Elapid snake envenomation

eBOOK

To view the full 2014 CVE webinar calendar and obtain further information visit: ***www.cve.edu.au/webinars***

4TH ANNUAL ROBERT DIXON ANIMAL WELFARE MEMORIAL SYMPOSIUM

DOES AUSTRALIA BREED COMPANION ANIMALS ETHICALLY?

Webster Lecture Hall,
Veterinary Science Conference Centre, University of Sydney
Monday 24 March 2014, 3pm to 5pm
All welcome

Dr Robert Dixon (1951-2011)
Champion for Animal Welfare

Robert Dixon graduated from the University of Sydney in 1973 with a BSc(Vet) degree before completing his BVSc degree in 1974. Robert completed his PhD in 1980 in New Zealand and returned to the University of Sydney in 1983 to take up an academic appointment within the Faculty of Veterinary Science. For many years Robert held the Faculty position of Sub-Dean Animal Welfare as well as serving on the University Animal Ethics Committee. Robert impressed his friends and colleagues with his determination, passion, positive attitude and sense of humour as he battled with ill-health throughout his life. Robert's email signature finished with a quote from Mohandas Gandhi – The greatness of a nation and its moral progress can be judged by the way its animals are treated.

To view past Robert Dixon Memorial Symposia please visit ***www.cve.edu.au/animalwelfare***

Back to TOC page

THANK YOU TO ALL CONTRIBUTORS

… and more C&T articles and Perspectives are needed

Thanks to every author who contributed articles or comments to the Control & Therapy Series (C&T) and to those who supplied images and visuals. Without your generosity the Series would cease to exist.

WINNERS

MAJOR PRIZE

Entitling the recipient to one year's free membership of the CVE

- **Mark Hynes:** The grass is always greener in the pulmonary side

WINNER OF BEST FILM CLIP

Entitling the recipient to a free DVD of their choice from the CVE's Vetbookshop *www.vetbookshop.com*

- **Mimi Dona** – Part 4: Wildlife flashcard series (Macropods)
- **Joyce Lauw & Chris McClelland** – Film clip of 'Lucy', the Bengal cat with localised tetanus

CVE PUBLICATION PRIZE WINNERS

Entitling the recipients to a CVE proceedings of their choice *www.vetbookshop.com*

- **Jim Euclid:** Possible craniosynostosis in Persian cats
- **Joyce Lauw & Chris McClelland:** Localised tetanus in a Bengal cat

All CVE Members who receive the print copy of the C&T Series are entitled to the e-book version

The e-book is the perfect complement to your print version. With the roll of your mouse you can bring up enlarged images or can you access additional content and view film clips.

Look for these symbols 

Contact the CVE today to ensure we have your current email cve.membership@sydney.edu.au or call (02) 9351 7979

CVE Members can access previous ebooks at *www.cve.edu.au/candtebook*

Congratulations to the Clinical Competency Prize Winners

Annually the CVE provides a Clinical Competency Prize at each of the Australian and New Zealand Universities.

Congratulations to the Prize Winners in 2013! You have been recognized for your outstanding clinical competency.

- CHARLES STURT UNIVERSITY: Catherine Tuckwell
- JAMES COOK UNIVERSITY: Liam Donaldson
- MASSEY UNIVERSITY: Stephanie Downer
- MURDOCH UNIVERSITY: Amy Forsythe
- QUEENSLAND UNIVERSITY: Tracey Gowan
- UNIVERSITY OF MELBOURNE: Kathy Luk
- UNIVERSITY OF SYDNEY: Duncan Pearce

Established in 1969, the C&T is the brainchild of Dr Tom Hungerford, first Director of the PGF (1968-1987), who wanted a forum for uncensored and unedited material. Tom wanted to get the clinicians writing.

Tom wanted to get the clinicians writing.

'…not the academic correctitudes, not the theoretical niceties, not the super correct platitudes that have passed the panel of review… not what he/she should have done, BUT WHAT HE/SHE DID, right or wrong, the full detail, revealing the actual "blood and dung and guts" of real practice as it happened, when tired, at night, in the rain in the paddock, poor lighting, no other vet to help.'

VALE
PAUL GOTIS-GRAHAM

Paul Gotis-Graham, veterinarian, animal lover, idealist and Renaissance man, died on the 13th January 2014 from acute myeloid leukaemia. He was 47. For six long years, Paul fought the aggressive leukaemia with the same spirit and determination as he displayed in building his eminent veterinary career, pursuing excellence in all aspects of his life, while supporting family, friends and colleagues. An inspiration to all who knew him, Paul lived his life to the full, right until the end.

Paul – and his dog 'Primo'

Paul graduated from the Faculty of Veterinary Science at Sydney University in 1989 with first class honours. The son of a veterinarian, Paul was particularly close to his mother Chrissie and his brothers Con and Ian. Paul ended up taking over his father's practice in Casula, buying him out in 1993 and continuing to run the hospital till 2011. This was a substantial undertaking for a recent graduate. Paul gave himself the brief of transforming the practice into a progressive one that focused on the needs of the clients and patients, whilst simultaneously upgrading the plant and facilities, to ensure that the veterinary care was of the highest quality. Through hard work, determination and significant natural ability, Paul was highly successful in this venture. He was greatly aided by his business partner and first wife, Miriam Meek. Together, they made a formidable and compassionate veterinary team. Other veterinarians who shared Paul's vision of veterinary practice soon joined him. Over the years Paul opened branch practices in neighbouring suburbs with Casula remaining the main treating hospital and focal point.

Paul was one of that endangered species, the omnicompetent clinician, comfortable with each and every aspect of small animal practice. His passion, however, was surgery, a discipline for which he showed both great aptitude and ability. Paul bought the best available range of surgery instrumentation, especially for the practice of his favoured orthopaedics. He undertook advanced training in orthopaedic surgery through courses, workshops and independent study. He completed his MACVSc in Small Animal Surgery by examination at the first attempt, and subsequently became an active member of that Chapter of the College, serving as its Treasurer (2004-2010), MACVSc examiner and was an active and dynamic member of its organising committee. Paul embraced the concept of life-long learning. He kept abreast of the latest developments in veterinary knowledge by constantly reading journals, attending seminars and courses, and undertaking cutting edge workshops. He would become excited by new techniques and new technology, and his enthusiasm was infectious.

Paul spent his whole career serving the people and pets of south-western Sydney. It's a complex part of Sydney, with a multicultural mix of people of widely varying socio-economic status and personal values. Paul and his team took all this into their stride, dealing most effectively with people from all walks of life. This speaks volumes for his ability to relate to different people, be a cogent and effective communicator and an advocate for his patients. While offering outstanding medical and surgical services to his patients and clients, Paul managed to create a thriving business enterprise. It was a matter of routine for Paul to conduct major surgeries on patients whose owners had strong emotional commitment, but without the accompanying ability to pay. It didn't matter to Paul and his team– they would more often than not just give it a go, and hope the people would eventually give him some recompense. Clearly, his joy came from helping the animal. Paul also had the notion of what he called "a learning case" – where if the owner didn't have the ability to pay, but the case represented a surgical or medical challenge which made the undertaking worthwhile, he would proceed to test and hone his surgical skills, while permitting him to develop or master a new technique. There is no doubt that after 10 years in practice he was routinely performing both orthopaedic and soft tissue procedures that most other practitioners would refer to a specialist surgeon, but at a fraction of the price of a referral surgeon. This meant a lot to his clients in the Liverpool area.

As an owner and manager, Paul was demanding of his staff who he expected to live up to his high but

practicable standards. Paul built enduring relationships with his team over the years, including his practice manager Liana Stramandinoli who worked with Paul for over 20 years. It was because he set the bar so high but at the same time was incredibly supportive and respectful, that he was a fantastic mentor for associates, who were willing to put in the hard yards.

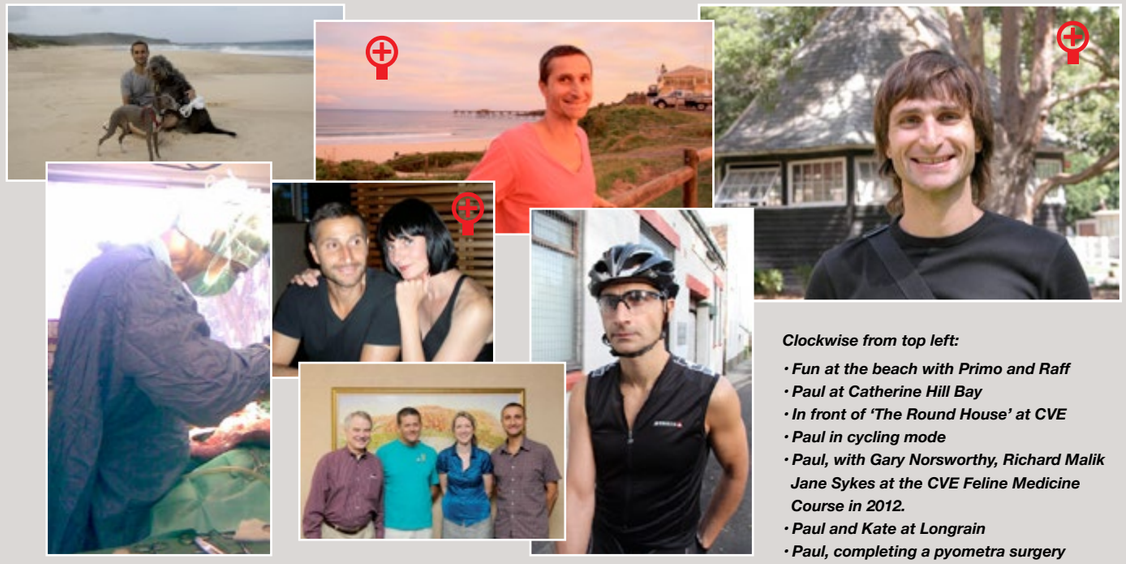
It was not possible for Paul to continue full-time practice after he became ill, but when in remission, he would return to the practice, and especially the operating theatre. Around this time Paul found additional ways to give something back to the profession by taking an active role in the management of the Centre for Veterinary Education (CVE; formerly the Postgraduate Foundation in Veterinary Science or PGF) and the Faculty of Veterinary Science, at the University of Sydney. Paul became a member of the CVE Council and challenged everybody with his take on the future of our rapidly changing profession, especially in relation to trends in practice and the use of technology. He also worked for the CVE as a consultant, and helped chair conferences and symposia, as well as being a sounding board for the Director, particularly during restructure of the organisation in 2013 through a change management process. In 2012 Paul returned to the Veterinary Faculty as a Tutor in Anatomy, and there was never a more effective demonstrator in this discipline than Paul, teaching students the importance of structure and function from the perspectives of both surgery and diagnostic imaging. Paul's intellectual curiosity and quiet confidence and competence also greatly buoyed the spirits of his anatomy colleagues. His was a grounding and welcome presence in the teaching team. He also helped out by doing sessional work at the Veterinary Teaching Hospital, mainly on weekends, where as usual, he was an engaging, challenging and inspirational teacher.

In the years following his diagnosis and subsequent treatments Paul was inspired to volunteer his professional skills. He taught surgical practices pro bono for a short time in Indonesia with a grassroots organisation that provide care to street dogs in Bali. Paul also worked with a homelessness service to provide free veterinary consultations to locals in the Kings Cross area. Paul found this work incredibly rewarding, as he was always touched by the care people showed their animals despite their economic situations.

There was a great deal more to Paul than veterinary science, as he was one of those individuals who worked and played hard, in equal measure. He was passionate about swimming, cycling, eating, cooking, coffee and music. He read widely, in all genres, had wide-ranging and eclectic tastes in cinema and fiction, and had a deep understanding of history, politics and world affairs. It's hard to know how he managed to squeeze all these interests into his life, considering the long hours he put in at Casula Veterinary Hospital and Elizabeth Drive Animal Hospital. Paul had an extraordinary large circle of acquaintances, from academics to bohemians, covering every social demographic imaginable. During his long battle with cancer, these friendships were deepened and strengthened, and special credit goes to his wife Kate who supported him through everything with her extraordinary love, strength of will and ability to make the most out of everything, and move forward. He also was greatly supported by his older brothers Con and Ian, and indeed his illness brought them all closer together. Paul was one of those people to make strong and enduring friendships, and he will leave a substantial legacy. His team at Casula continue to practise veterinary medicine with the philosophy he instilled in them, and Agnes Chiu is a deserving yet reluctant protégé, and very proud to accept the baton from Paul. Penny Tisdall, who started with Paul as a new graduate, is now the senior surgical specialist in Adelaide, and no doubt her career trajectory and moral compass had a lot to do with the formative years she spent at Casula.

Paul was a very special human being who enriched the lives of others. He was a man of many talents and interests who cared deeply about people, pets (including his own menagerie of cats and dogs) and life. Paul always said, 'It's about making a difference' and what a difference he had made to everyone he touched. Paul is survived by his wife Kate, his brothers Con and Ian, his sister-in-law Christina and by his two nieces Stephanie and Anna. Vale Paul Gotis-Graham.

Richard Malik, Agnes Chiu, Corinna Klupiec, Wallace Lee, Penny Tisdall, Kate DeMaere and Paul J Canfield



Clockwise from top left:

- ***Fun at the beach with Primo and Raff***
- ***Paul at Catherine Hill Bay***
- ***In front of 'The Round House' at CVE***
- ***Paul in cycling mode***
- ***Paul, with Gary Norsworthy, Richard Malik Jane Sykes at the CVE Feline Medicine Course in 2012.***
- ***Paul and Kate at Longrain***
- ***Paul, completing a pyometra surgery***

WINNER OF BEST FILM CLIP

PART 4: WILDLIFE FLASHCARD SERIES
MACROPODS

C&T NO. 5374

Mimi Dona
Lecturer on Animal Studies and Sustainability
at the Metropolitan South Institute of TAFE

Senior Veterinary Nurse – Currumbin Wildlife
Sanctuary Veterinary Hospital (CWS)
27 Mllers Dr, Currumbin QLD 4223

This series is the result of collaboration between Mimi Dona & Dr Michael Pyne of Currumbin Wildlife Sanctuary Veterinary Hospital. Film clips courtesy of Lincoln Williams, Fotomedia (www.*fotomedia.com.au*). Non CVE members can access these flashcards and videos at ***www.cve.edu.au/candt2013***

eBOOK

Film clip courtesy of Lincoln Williams
fotomedia.com.au

Macropods

Be aware:

- Can inflict a nasty bite, scratch and have a powerful kick that can cause significant trauma.
- Adult macropods are difficult to restrain manually – should be chemically restrained for transport/ treatment.
- All pouch emerging joeys and adults should be assessed for myopathy. Adult macropods do not cope with being in captivity and succumb to myopathy very quickly, especially following trauma-related incidences.
- Female Macropods have a pouch; always check for joeys. Never pull a Joey off the teat; remove very gently or cut the teat off the bottle and pin to the inside of a cotton pouch liner.
- Unfurred joeys require regular feeding (every 2 to 3 hours) and until they reach pouch emergence stimulation for defecation and urination.
- Marsupial young are born very under-developed and until the stage of development that we are able to successfully hand rear young joeys, they are considered to be 'unviable'. Consult a trained/experienced person for assistance with identification and confirmation on viability.
- Native marsupials don't get tick paralysis.

Handling

- Take care not to induce myopathy when attempting to capture or restrain macropods.
- Medium to large macropods need to be chemically restrained; due to the risk they should only be caught by someone experienced/trained. To restrain a large macropod that is on the ground unable to get up, use several people to go in from behind, sharing the weight to hold down the tail and shoulder area, stopping it from turning. Cover the head with a towel and stay away from the legs. Mobile and injured macropods will require a licensed person with a dart/ tranquilizer.
- For small macropods, grab the base of the tail near the rump and lift off the ground facing the legs away from you and away from others. Support the chest with the other hand and face the legs away from you and others. To place in a bag (pouch) have someone hold it open and place the joey head first directing the body into a u-shape.
- Small joeys can be cupped in your hands and placed into a pouch.
- Older joeys can be handled in the same manner as adults above.

Back to TOC page

Housing the sick or injured macropod

- Preferred enclosure temperature for Adults is 28˚C. Orphaned joeys just furred to furred 28˚C to 30˚C and 32˚C for unfurred.
- Pinkies can be placed in a cotton pouch in a plastic aquarium lined with towels and must be given heat – just furred/furred 28˚C to 32˚C and unfurred 32˚C. Ideally they should be housed in a Vetario® or Humidicrib. This must be monitored with an indoor/outdoor thermometer.
- To reduce stress, place furred orphans in a cotton pouch and then in a make shift pouch using a pillowcase and coat hanger. Place towels underneath and inside for additional comfort and support. Always provide a quiet place during the day and a safe closed room in case they get out. Alternatively the cotton pouch can be placed in a plastic carry cage lined with towels or small blankets.
- Large joeys can be housed temporarily on a soft bed post-operatively or if unable to move and in a recumbent state. Hand raised joeys once standing can temporarily be housed in a room (free of clutter) or outside pen.

Figure 1. Use a Bair hugger® and room temperature to maintain the patient's core body temperature throughout the procedure, using a cloacal thermometer to monitor.

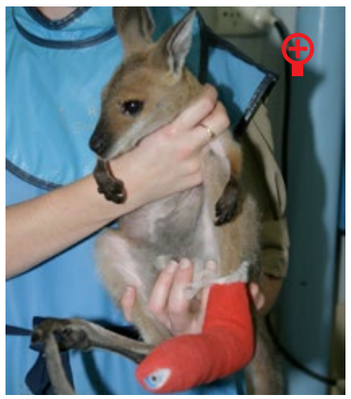


Figure 3. Always direct the feet away from the handler; even small macropods have a powerful kick.

Emergency diet

- Only offer food once rehydrated.
- If you are familiar with the species, grasses, native herbs and vegetation (be careful where collected avoid sprayed/contaminated areas) are ideal for just-furred and onwards.
- Orphans can be given water and glucodin initially for first two feeds, then suitable milk replacer (Divetelact®, Biolac® M 100 or Wombaroo® Kangaroo Milk Replacer. This can be given either via a 1mL syringe with catheter tip, bottle and appropriate sized teat.

Figure 2. Take care not to induce myopathy when attempting to capture or restrain macropods.

Assessment under anaesthetic

Gaseous

- Use an anaesthetic mask at 5% induction, can take up to 5 minutes (very stressful with wild macropods; best to use suggested injectable agent)
- Maintain using a mask on isoflurane at 1.5 to 2% with an oxygen flow rate of 1 L/min.

Anaesthetic agents

Zoletil
- Small to medium – 10mg/kg – (I/M)
- Medium to large – 5mg/kg – (I/M)

Alfaxan CD RTU 3 mg/kg – (I/M)

Due to the difficulty with intubation of Small Macropods and IPPV in case of apnoea, gaseous anaesthesia is recommended.

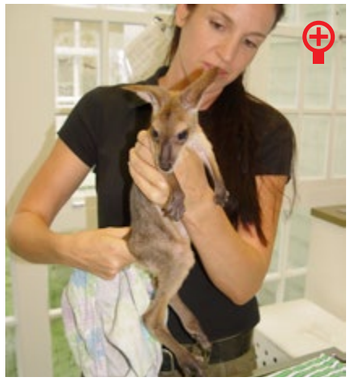


Figure 4. Small joeys can be handled in your hands; maintain in a pouch whenever possible to reduce stress.

Figure 5. A make-shift pouch can be made using a pillowcase and a coat hanger.

Figure 6. Small furred joeys can be housed temporarily on a soft bed post-operatively, or if unable to move and in a recumbent state.

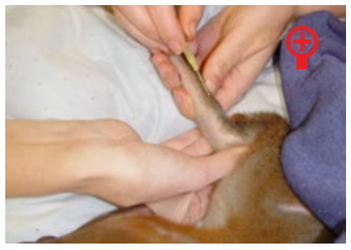


Figure 8. The lateral caudal tail vein is the preferred route for intravenous access.

Figure 7. Unfurred joeys require stimulation for defection and urination until they reach pouch emergence.

Intubation

Intubation is difficult in macropods and respiration under anaesthesia is reliable. Intubation is generally reserved for when oral/facial surgery is required and a facemask is not possible.

Cuffed endotracheal tube or catheter tip, insert the endotracheal tube with the aid of an anaesthetic spray and tie in with shoelaces.

Recovery

Be careful of uncontained larger macropods when waking up from anaesthetic as they can wake up very quickly.

Use a Bair hugger® or heat mat and room temperature to maintain the patient's core body temperature throughout the procedure, using a cloacal thermometer to monitor. With joeys, Vetario® or Humidicribs are ideal during post-operative recovery.

Myopathy – poor prognosis

Vitamin E Selenium can be used as a preventative treatment
- Mild cases or as a preventative 1mL/50kg SID for 3 days (I/M
- Moderate cases (bad orphaning) 1mL/30kg SID for 3 days (I/M)
- Severe cases (dog attack etc) 1mL/20kg SID for 3 days (I/M)

Pamlin
- 1mL per 10 kg for mild sedation and 1mL per 5kg for heavy sedation.
- Fluid therapy

Fluid Therapy

It is important to remember to warm the fluids being administered. Using 0.9% sodium chloride, dose the patient at 5% of its bodyweight. Fluid therapy can be administered subcutaneously or standard I/V infusion rates. Syringe pumps are ideal to use in orphans.

Preferred routes of drug administration

- Subcutaneous – administered in loose skin at lateral neck/chest, side of abdomen or over thigh area.
- Oral – given via a syringe.
- Intramuscular – administered to dorsal lumbar muscles, cranial and caudal thigh, upper arm, gluteals.
- Intravenous – lateral caudal tail vein is preferred or cephalic, saphenous.

Euthanasia methods

Injection of sodium pentobarbitone can be administered either by intravenous, intracardiac or intraperitoneal routes.

- If administering by intracardiac or intraperitoneal, macropods must be anaesthetised first. Pinkies do not always reach appropriate levels of anaesthesia in a gas chamber, Alfaxan® I/M is recommended.

Back to TOC page

LUMPY JAW SUCCESS STORY

C&T NO. 5375

Al Warner

BVSc MAppSc (Wildlife Health) MANZCVS (Avian Health)
– published post humously

James Phelan

BVSc DipWildlifeMed

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On Monday 07.11.12 my colleague Dr Jim Phelan and I were attending a native fauna exhibit to capture a young male swamp wallaby (*Wallabia bicolour*) prior to castrating him and we were asked to check a young white female Red Neck wallaby (*Macropus rufogriseus*) (Fig. 1).

She had a swelling over the caudal aspect of the right maxilla and swollen eyelids of the right eye (Fig. 2).

The swelling had been present for no more than 2 days over the weekend. The attendant had been feeding the joey formula daily on week days and she is a keenly observant carer.

My initial thought was *'I hope this is bruising caused by a collision with a fence or enclosure equipment but since this unusual animal is the subject of a naming competition among the local primary school kids, I bet it is lumpy jaw!'* We have treated 'lumpy jaw' in a variety of wallaby species and eastern Grey kangaroos without great success.

Because we were fully occupied with capturing and transporting the animal to be castrated, we did not have time to examine the joey closely. I asked the carer to ring me the following day hoping that the swelling might subside if it had been due to bruising. Not unexpectedly, the carer reported that swelling was possibly more pronounced the following day and she was advised to bring the joey to our clinic for a detailed clinical examination. Palpation over the right maxilla revealed a swelling that could have been cellulitis, a haematoma, an abscess or osteomyelitis (Lumpy jaw).

We elected to anaesthetise the joey as examining macropods' teeth is not an easy procedure. She was given an injection 0.5 mg/kg of diazepam (Pamlin 5mg/mL, Parnell) in the anterior thigh musculature and after 15 minutes she was sufficiently relaxed to be anaesthetised via face mask with 5% Isoflurane (Isoflo, Abbott Australasia) in 100% oxygen. (Fig. 3)

The most rostral of the 4 right maxillary molar teeth was found to be loose and there was a blood stained exudate at the gingival border. There was also significant swelling of the buccal gingiva. Radiographs showed a lack of bone density at the base of the loose molar. The molar was extracted without difficulty and the alveolus was swabbed for bacterial culture and susceptibility testing.

Results of the culture were obtained from Vetnostics on 11.11.12. Anaerobic bacteria had been cultured. Susceptibility testing was not done and the laboratory commented that *'Anaerobes are predictably susceptible to Metronidazole®. Alternative agents include clindamycin and Augmentin.'*

There are ample reports in the literature and on the internet that outline various treatment regimes for this condition. Various bacteria have been cited as the primary infectious agents in this condition, how they invade the tissue and how a variety of secondary infectious agents relished the pathological changes and proliferated *in situ.*

Anaesthetising the animal and extracting loose teeth with surgical debridement of the infected bone and delivering an appropriate course of antibiotic(s) is the recommended treatment.

The first consideration in assessing a treatment plan for this condition is whether or not the animal is suitable for treatment and then whether or not there is someone capable of administering the treatment. Many times we do not get past this first step and euthanasia is a better alternative than painful slow starvation.

The carer was given a guarded prognosis but she was attached to the animal and was willing to do whatever was required to help. We then had to find the required antibiotics in a form that could be administered by the carer by herself. This was not a simple task.

We first opted for a combination of Clavulox® and metronidazole. However the metronidazole we could source was a low concentration, high volume human preparation available as an intravenous infusion. This was not practical in this case. We did not consider an oral preparation because of concerns of possibly eliminating normal enteric flora and causing intractable diarrhoea.

Our second choice was clindamycin (11mg/kg bid, Dalacin C Phosphate Injection 300mg/2mL. Pfizer Australia.) and Clavulox® 10 mg/Kg sid (140 mg/mL Amoxycillin Trihydrate & 35 mg/mL Clavulanic Acid. Pfizer Animal Health.) and this was started on 16.11.12.

The carer was concerned that the antibiotics would change the gut flora and cause diarrhoea. We explained that we also were concerned about this possibility but that the likely outcome of not administering an effective antibiotic course would be one deceased joey. We had previously instructed the carer, who had completed an animal care course at TAFE, on how to administer the injectable antibiotics.

Figure 1. Female white red necked wallaby.

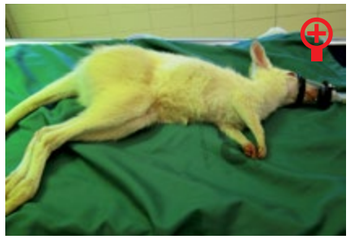

Figure 3. Examination of the teeth was conducted after the anaesthetic was administered.

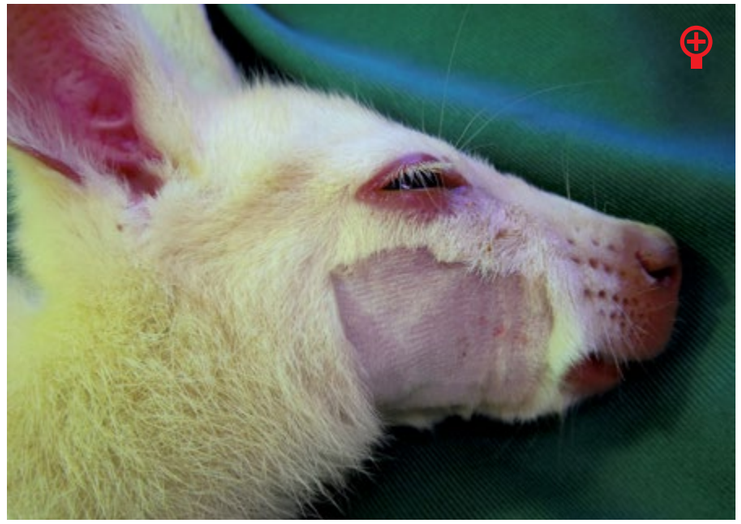

Figure 2. Note swelling over the caudal aspect of the right maxilla and swollen eyelids of the right eye.

This joey had been housed with her mother and other wallabies in an open air enclosure. Her diet had been supplemented by bottle feeding Biolac M 200 (2 scoops equivalent to 24 g powder/100mL warm water) formula once daily and was no trouble for the carer to handle. We decided to separate the joey from her mother for the course of the treatment so that the carer could take her home on weekends and also for a 3 week period when she took annual leave on the North Coast. There was some stress involved in separating the animals and confining the joey indoors and we administered Modecate® (Fluphenazine decanoate 50 mg in 2 mL. Bristol-Myers Squibb Aust. P/L) at a dose of 2.5 mg/kg. I.M. on 16.11.12.

The joey tolerated the injections and appeared relaxed with her carer on the numerous occasions when I examined her. There were a few days when the joey did have pasty faeces but she never stopped drinking her formula and continued to gain weight. That was an encouraging sign. The swelling over the maxilla fluctuated in size and on 27.11.12 we again anaesthetised the joey to examine her mouth. The second molar was loose and was removed. On the same day the carer left with the joey on her annual holidays. We were concerned that the antibiotic course was ineffective but decided to prolong the course. She was supplied with 3 weeks of Clavulox® and Clindamycin® in syringes.

Figure 4. Al, caring for Lily.

On 17.12.12 I examined the joey on site and administered a second dose of Modecate and supplied the carer with more Clindamycin®. We arranged to examine her mouth while anaesthetised and did so at our clinic on 19.12.12. At that time the swelling had gone and the remaining teeth were firm and there was no apparent inflammation. The Clavulox® and Clindamycin were continued for a further 2 weeks. The joey has been returned to the enclosure with her mother and several other wallabies and has had no recurrence as of 13.05.13. The winner of the naming competition chose 'Lily' for her name. I would have chosen 'Lucky'.

A point of interest in this case includes the length of the course of the appropriate antibiotics to achieve a cure. If presented with an animal with lumpy jaw the carers / owners must be advised of the labor intensive process, the cost of the antibiotics and the possibility of repeated anaesthetics to monitor and treat infected bony tissue. Even at our 'friendly' rates the cost of this exercise was substantial.

Authors' views are not necessarily those of the CVE

Back to TOC page

Another consideration in this case is that the opposing molars to those that were extracted may elongate or develop sharp spurs because they may not be ground down during mastication. These molars may need to be rasped in the future.

We have experienced poor outcomes in the past in treating this condition and have researched the various treatment regimes that have been recommended. This animal responded to the antibiotic and surgical intervention we have described.

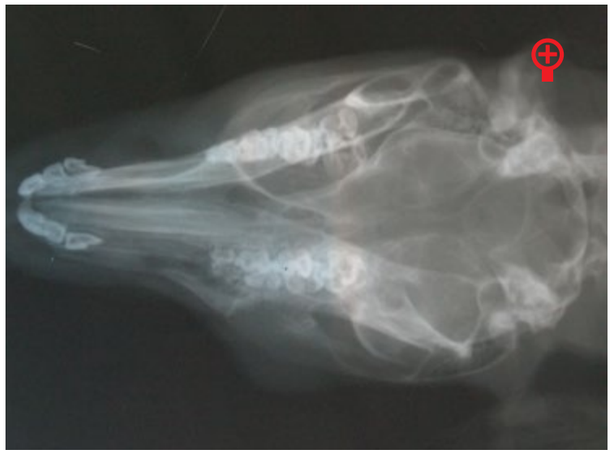

Figure 5. Ventrodorsal radiograph.

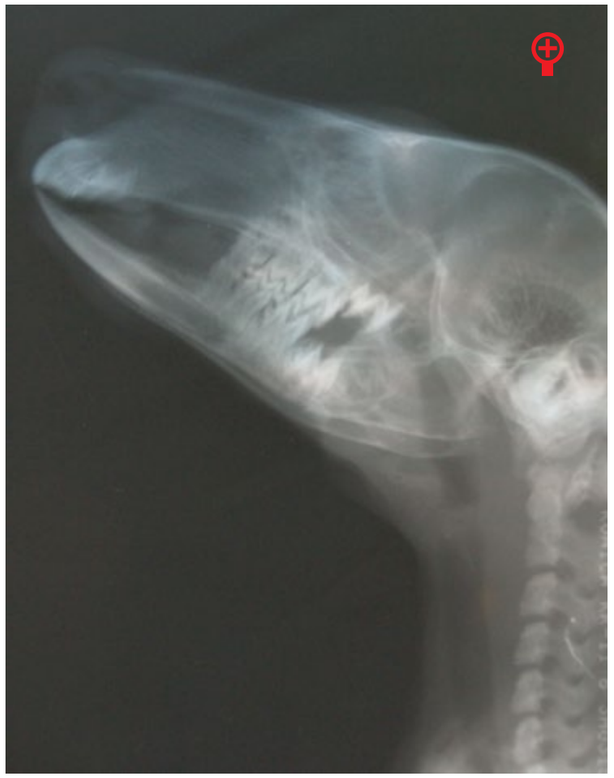

Figure 6. Lateral radiograph.

INVITED COMMENTARY COURTESY OF:

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This is a good article regarding the difficulties encountered in attempting to treat lumpy jaw in macropods.

In the young wallaby, the first 2 'molars' are actually premolars which will eventually be followed by 4 molars so perhaps it would be better to just refer to these teeth as cheek teeth to avoid confusion. The Red-necked Wallaby undergoes molar progression as it ages with the caudal molars pushing the arcades forward as they erupt (in fact, this is used for ageing purposes). This usually results in the shedding of the more rostral teeth.

The process of odontoclastic root resorption allows these teeth to be lost and the inflammatory responses in the vicinity of the tooth roots is a perfect environment for bacterial proliferation especially of anaerobic bacteria such as Actinomyces spp. etc. Radiographs of this young wallaby show the presence of erupting molars which are causing some displacement of the teeth already present in the arcades. In herbivorous animals rotation or malposition of any teeth in a tightly packed arcade allows food trapping and decomposition (this is the form that periodontal disease takes in these species) with proliferation of anaerobes especially. Unfortunately for macropods, infection with these anaerobes can spread to the adjacent bony structures and lead to lumpy jaw.

Treatment of choice for these infections is good debridement, where possible, followed by sodium iodide injections usually with good results. Unfortunately sodium iodide frequently has untoward reactions in macropods hence other therapies are needed such as clindamycin. Chlorhexidine oral washing after thorough surgical debridement has also been used with success in wallabies that are amenable to the frequent restraint required for this type of treatment regime. These animals can be trained to accept a flavoured chlorhexidine relatively quickly (Hexarinse®, Virbac).

As pointed out in the article, cost of treatment is always an issue with these and euthanasia is an option. The macropod teeth are brachydont type and I have not found overgrowth of opposing teeth to be an issue but packing of food into the cheeks adjacent to missing teeth can be.

Once again, this is a good article demonstrating a valid approach to treatment of lumpy jaw.

PERSPECTIVE NO. 102

EXERTIONAL HEAT ILLNESS IN THOROUGHBRED RACEHORSES: OBSERVATIONS AND TREATMENT IN THE FIELD

C&T NO. 5376

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The author would like to acknowledge the influence of Professor David Hutchins in learning to appreciate the value of simple clinical observations.

Data on the incidence of exertional heat illness (EHI) in thoroughbred racehorses is unavailable but during the summer months in eastern Australia when the ambient temperature and humidity are high, horses suffering from EHI manifesting as a heat stress/heat stroke syndrome are not uncommon. Appropriate management of these horses is critical as EHI represents a medical emergency. This article attempts to define and describe the spectrum of EHI syndromes and to provide a rationale for treatment protocols in the field.

Introduction

The thoroughbred racehorse is an exceptional athlete, galloping at very high work intensity at speeds of about 70 kilometres per hour over relatively short distances, with some races completed in less than a minute. To achieve this, the heart rate peaks at 250 beats per minute, cardiac output may rise to 450 litres a minute and oxygen consumption is from 160 to 200 millilitres of oxygen per kilogram per minute (Sharp, 2012; Young, 2003; Hodgson and Forman, 2014).

It has been calculated (Hodgson, 2014) that heat production under such circumstances can reach 450 kcal/minute, and possibly elevate core body temperature by about 1°C/minute. Unless the heat stored during exercise is dissipated the body temperature will continue to rise to a hypothetical 42°C, which has dire consequences for the animal concerned because heat is toxic to cells and initiates a complex, progressive array of pathophysiology (Bouchama and Knochel, 2002).

In moderate environmental conditions (for example, temperature 20 to 25°C and humidity below 30%) metabolic heat from strenuous exercise is dissipated by radiation and convection to the atmosphere and through evaporative cooling by sweating. However, when the skin temperature and ambient temperature are equal, evaporative cooling is the only avenue for heat loss. In conditions where there is high ambient humidity, the water vapor pressure gradient from skin to air is decreased, thus limiting the ability of the body to lose heat by sweating and posing a serious threat to thermoregulation (McCutcheon and Geor, 2004).

While the physiology of thermoregulation in the horse is comprehensively described in the literature (for example, Guthrie and Lund, 1998; Hodgson, 2014; Hinchcliff *et al.,* 2004; Hodgson *et al.,* 1994), there is scant information on the clinical syndromes of thermodysregulation observed in thoroughbred racehorses, whose performances are characterized by short bursts of strenuous, largely anaerobic activity at high intensities (Gerard *et al.,* 2014). This is in sharp contrast to the endurance horse, whose heat exhaustion syndromes have been extremely well documented but are essentially quite different, endurance activity being by nature aerobic, protracted and submaximal in nature, with dehydration a key feature (Lucke and Hall 1980; Landon Fielding *et al.,* 2009).

In the capacity of a race day official veterinarian for Racing New South Wales, the regulatory racing body in New South Wales (NSW), Australia, the author has over a period of twenty years observed and treated horses presenting with EHI syndromes. Unquestionably, such cases constitute a real medical emergency and are extremely challenging because of the narrow time "window" (Yuval *et al.,* 2004) of opportunity for recognition and effective treatment. The highest priority therapeutic objective is to reduce core body temperature to a safe level within thirty minutes if possible, but certainly in no longer than sixty minutes, as recommended by Casa *et al.,* 2007 in humans.

Back to TOC page

This paper defines the syndrome of EHI in the thoroughbred horse, describes the spectrum of clinical signs, and presents the rationale for treatment in the field.

Description of Exertional Heat Illness (EHI) in the Thoroughbred Race Horse

EHI is represented by a continuum of clinical signs along a common pathway from the milder forms of EHI through to heat stroke and death (see Table 1). EHI is seen most commonly in thoroughbred racehorses competing under hot and humid weather conditions, when the mechanism of evaporative heat loss through sweating becomes relatively inefficient at controlling body temperature.

The wet-bulb globe temperature (WBGT°C)^{shade} is by far the most widely accepted index of heat stress used throughout the world. It takes into account air temperature, humidity and wind velocity to provide a single reading, and there are well-established limit values to help users interpret readings and thus predict the risk of thermal injury (Yaglou and Minard, 1957; Casa and Roberts, 2003; Budd, 2008). The concept of WBGT was introduced in the early 1950s in an attempt to control heat illness in training camps of the United States Armed Services and since that time has been adopted by sporting regulatory bodies world-wide, the US Occupational Health authorities and the American College of Sports Medicine. For humans, WGBT levels of 21 to 25 are considered to represent moderate to high risk of thermal injury; 26-29 high to very high risk; and readings over 30 indicate extreme risk (Sports medicine Australia, 2013; Binkley et al., 2002). Schroter and colleagues (1966) used the WBGT to quantify environmental heat loads during the three-day event competitions at the Atlanta Olympics.

Racing NSW, the regulatory body for horse racing in New South Wales, Australia, has adopted policy recommendations concerning racing in hot weather based on WBGT levels (Racing NSW, 2009). Above a certain level, WBGT 26°C^{shade} to 28°C^{shade} there are changes to race-day programming and procedures, the provision of strategically placed hoses, quantities of ice made available and an extra veterinarian assigned to monitor post race recovery and to treat

Table 1. Exertional Heat Illness Syndromes in Thoroughbred Race Horses

CONTINUUM

CENTRAL NERVOUS SYSTEM DYSFUNCTION

HEAT STRESS	Note: Horses may enter at any point along this continuum
Level 1	'HOT' distressed; skin hot to the touch. Heart rate > 130, respiratory > 60/ min **Normal mentation**
Level 2	'HOT' distressed; elevated HR + RR **Irritability –** uncooperative; unusual behaviors – head shaking, kicking out – may be confused with colic.
Level 3	'HOT' distressed; elevated HR + RR **Abnormal mentation –** toward depression, disorientation. Increasingly difficult and dangerous behaviors, unwillingness to move or sudden plunging and stopping haphazardly, wobbly, becoming unmanageable.
Level 4	'HOT' distressed; elevated HR + RR **Substantial levels of central nervous system dysfunction.** Horse extremely dangerous to itself and handlers, ataxic and uncoordinated – may fall over repeatedly, plunging to its feet, colliding with objects or people in its way.
HEAT STROKE	
DEATH	**Clinical signs of endotoxaemla are apparent: membranes hyperaemic or "lolly" pink with slow capillary refill times.**

Table 2: Treatment Protocols for Various Levels of Exertional Heat Illness

Level 1: 'HOT' horses

- Need to be effectively cooled with copious amounts of cold (iced) water by hosing or bucketing and scraping the heated water off the skin.
- Important to monitor heart and respiration rates and skin surface temperature.

Level 2: 'HOT' horses + irritability

- Need to be effectively cooled as above.
- Provide sedation and inhibit serotoninergic activity. — Detomidine (10mg/mL) – recommended dose rates for this level are 5µg/kg or 0.25mLs **OR** Xylazine (100mg/mL) at 0.5 to 1.1mg/kg (2.5 to 5.0 mLs) intravenously.
- If clinical condition not improving as judged by still elevated heart and respiratory rates, give NSAID to control SIRS. — Flunixin meglumine – (50mg/mL) as bolus at a dose of 1.1 mg/kg or 10 mLs.

Level 3: 'HOT' horses + altered mentation + incoordination 'wobbly'

- Need to be effectively cooled as above.
- Provide sedation and inhibit serotoninergic activity. — Detomidine (10mg/mL) – increase dose to 30µg/kg or 1.0 to 1.5mLs IV incremental doses to effect.
- Provide flunixin meglumine to control SIRS.
- Provide neuroprotection and stabilize cell membranes. — Dexamethasone (5mg/mL) as bolus at a dose of 0.1 to 0.2 mg/kg or 10-20mLs intravenously.
- Address hydration status – may need to give fluids intravenously once central nervous system signs are under control.

Level 4: 'HOT' horses + gross signs of central nervous system dysfunction – falling over – dangerous

- Need to be effectively cooled as above.
- Provide sedation and inhibit serotoninergic activity. — Detomidine at highest dose rate to control nervous system dysfunction and provide serotoninergic depression.
- Provide flunixin meglumine to control SIRS.
- Provide neuroprotection. — Dexamethasone at highest dose rate 0.5 to 2mg/KG intravenously
- Address hydration status – may need to give intravenous fluids.

horses with signs of EHI if necessary. In the author's experience the WBGT has been useful in predicting the occurrence of EHI; once a level of at least 24 was reached it was highly likely that on that day we would encounter an increased number of horses with thermoregulatory problems after racing. It should be pointed out, however, that it is a misconception to assume that EHI will only occur on hot days. This author has seen cases of EHI on relatively cool days, and Roberts (2006) has reported heat-related illnesses in humans at an air temperature of only 9.4°C but with relatively high humidity.

In my experience, the clinical continuum of EHI, in order of increasing severity, includes horses that present as:-

(a) **Level 1** – Very 'hot' and distressed (see Fig. 3). There are increased rates of respiration (>60-100 breaths per minute) with widely dilated nostrils and heaving thoracic excursions. The heart rate is always elevated > 150 beats per minute and the animal is usually sweating profusely. Most importantly the skin is extremely hot to the touch.

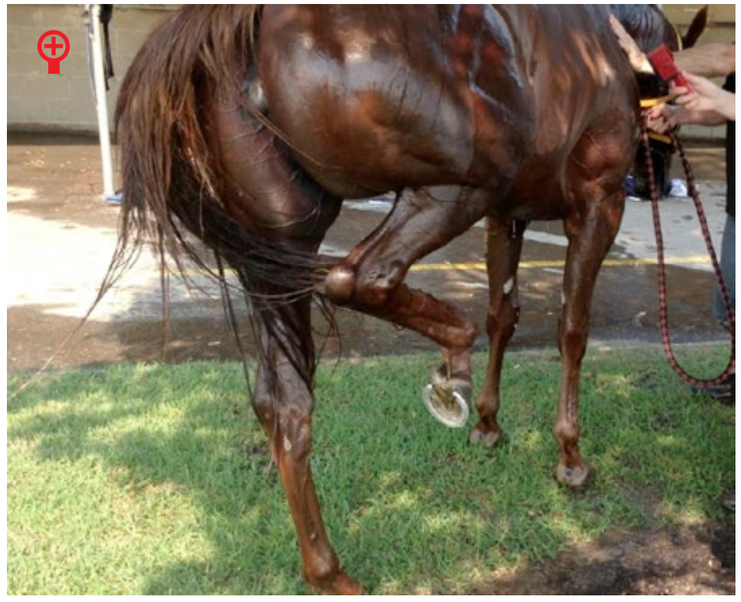
(b) **Level 2** – Irritability: these animals demonstrate unusual behaviors such as kicking out in a random fashion (which may be confused with a colic episode) and are becoming uncooperative (see Fig. 2).

(c) **Level 3** – Altered mentation toward depression and incoordination (wobbly) may be evident. Horses in this group can become unmanageable, plunging and stopping haphazardly with disorientation (see Fig. 1 and Fig. 6 on page 20).

(d) **Level 4** – The final stage, 'heat stroke', is where the horse demonstrates substantial levels of central nervous system dysfunction (encephalopathy), throws itself down or falls down repeatedly and is a risk to itself and its handlers. This latter group will progress towards death unless treated rapidly and effectively (see Fig. 4).

All horses in the above groups have tachycardia and hyperventilation (see Table 1). It should be pointed out that a particular horse may be first observed at any point along this continuum, depending upon the conditions of the day, its individual risk factors, and its

Figure 1.



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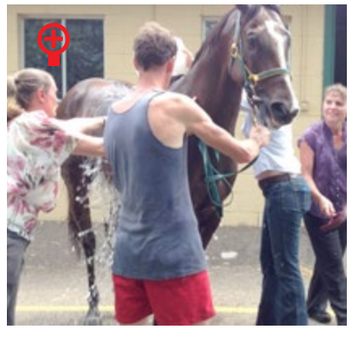


Figure 3.

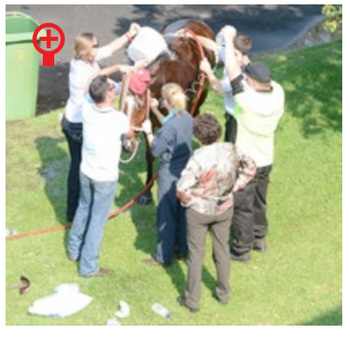


Figure 4.

Back to TOC page

core body temperature elevation. It is also important to emphasize that a diagnosis of EHI should not rely solely on the clinical finding of an elevated rectal temperature because this may not be observed due to the lag period of heat build-up post race, often a flaccid empty posterior rectum, and the risk involved in actually taking a temperature from an animal with irritability and altered mentation. It is not considered necessary or a priority to establish hyperthermia before instituting treatment.

TREATMENT PROTOCOLS FOR EXERTIONAL HEAT ILLNESS

Effective and rapid cooling

It is considered an absolute priority that horses with EHI are recognized early, and this requires the active involvement of those who are familiar with the variations in clinical signs described above. Alternatively, horses whose heart and respiratory rates remain elevated post-race can be targeted and presented to the treatment group for evaluation. Ideally, the treatment area should contain a wet room where horses can be hosed and where iced water is readily available. An air-conditioning unit or large fan is also advisable.

Effective cooling strategies are the cornerstone of treatment. Casa and colleagues (2007; 2010) have investigated a wide variety of cooling modalities, concluding that ice-cold water immersion is the gold standard for treatment of exertional heatstroke in humans. The physical characteristics of water make it vastly superior to air as a cooling medium. Firstly, water's thermal conductivity of 630.5 mW/m^2 per ^{o}K gives it a much greater potential for heat transfer than air (26.2 mW/m^2 per ^{o}K). Secondly, the specific heat of water is 4.2J/g per ^{o}K compared with 1.0J/g per ^{o}K for air, and the density of water is 0.9922 g/cm^3 against 0.0012 g/cm^3 for air. The volume-specific heat capacity of water is therefore nearly 3500 times greater than that of air. These factors, combined with water's more effective skin contact, mean that a body can cool four times faster in water than in air of the same temperature. Golden and Tipton (2002) have concluded that water provides the same cooling capacity as air that is 11°C colder.

Critics of the iced water cooling modality argue that it may be counterproductive because it initiates peripheral vasoconstriction (PVC), which reduces the transfer of heat from the core to the skin. However, Casa and co-workers (2007) have strongly argued that such a response is typical only with normothermic individuals immersed in cold water who need to defend their body temperature. It has been shown experimentally in humans that individuals who are hyperthermic due to EHI have blunted responses in terms of PVC (Clements *et al.*, 2002: Golden and Tipton, 2002; Proulx *et al.*, 2003; Toner and McArdle, 1996). Even with some degree of initial PVC, the overall transfer of heat from the core to the skin during the critical period is far greater in cold water than in air. From a clinical viewpoint, the fact that a lowering of core body temperature must be achieved in a limited time demands the most efficient cooling modality available.

Cooling in the horse has been well described in the literature (Hodgson, 2014; Jeffcott and Kohn, 1999; McCutcheon and Geor, 2014; Marlin *et al.*, 1998; Williamson *et al.*, 1995) and is best achieved by a team of three people using cycles of hosing with water of sufficient volume, pressure, and low enough temperature to establish a gradient for rapid exchange of heat from core to skin to water. The water is then scraped off and the cycle continued. Attention needs to be paid to the great vessels of the head and neck, the area between the front and back legs, and of course the major body mass. Scraping is essential: if the water is allowed to warm up on the skin the temperature gradient will decrease, reducing the transfer of heat.

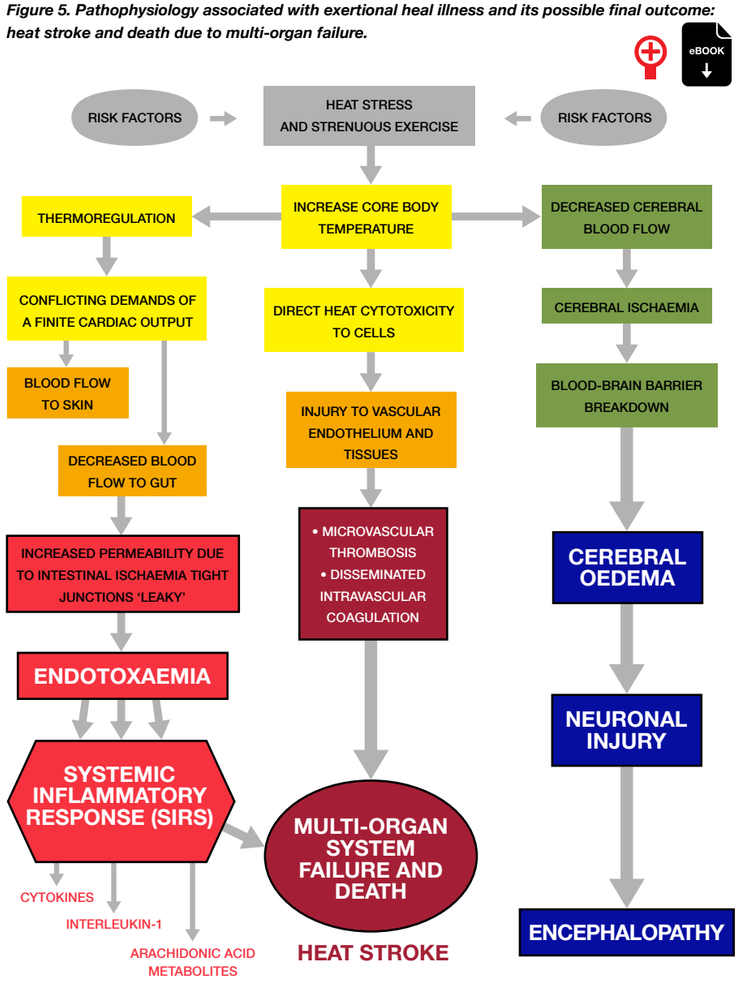
Throughout this procedure it is important to monitor heart and respiratory rates and to observe and feel the heat from the skin surface. Once cooling has been achieved the horse can be discharged from the treatment area, however there is a tendency for these horses to present with a rebound hyperthermia about 30 minutes later so that they need to be kept under surveillance and the whole process of cooling may need to be repeated.

The pathophysiology of the EHI pathway and implications for other treatment modalities

Research in humans in the last decade (Epstein and Roberts, 2011; Leon and Helwig, 2010; Bouchama and Knochel, 2002) has provided insights into the pathophysiology of heat stroke and suggested an integrated view, depicting a common pathway from heat stress to heat stroke (see Fig. 5). This has important implications for treatment because it explains the progressive nature of the condition and therefore the need for all phases of EHI to be treated as aggressively as possible. There is convincing evidence that the severity of the illness will be determined by the critical thermal maximum, a term which attempts to quantify the level and duration of elevation in cell temperature that will initiate and potentiate progressive tissue injury (Shapiro *et al.*, 1973; Bynum *et al.*, 1978).

Briefly, from the model of heat stroke based on observations in humans (Bouchama and Knochel, 2002; Leon and Helwig, 2010) and experimental models of heat stroke in laboratory animals, it is suggested that during strenuous exercise there is an elevation of core temperature which stimulates physiological changes. Flow of blood to the skin is increased to accelerate heat transfer to the environment and if this is effective the body core will cool without consequence. This redistribution involves a decrease in blood flow to the gut, and if this is prolonged gut ischemia will result, stimulating oxidative and nitrosative stress. The tight junctions of intestinal epithelial cells increase their permeability and allow the leakage of bacterial endotoxin, which then gains access to the systemic circulation (Dokladny *et al.*, 2006: Lambert *et al.*, 2002). In heat stressed primates endotoxin from the gut enters the circulation at a core temperature of 40^{o}C and its concentration increases as the core temperature rises (Gathiram *et al.*, 1987). The immune system responds to endotoxaemia by activation of the systemic inflammatory response syndrome (SIRS) with increased production of cytokines, interleukin-1 and other immune modulators including prostaglandins. This will cause haemodynamic instability, cardiovascular

Figure 5. Pathophysiology associated with exertional heal illness and its possible final outcome: heat stroke and death due to multi-organ failure.



collapse and shock. In concert with the above, hyperthermia also causes thermal injury to the vascular endothelium, initiating coagulation pathways that lead to microvascular thrombosis and disseminated intravascular coagulation (DIC) (Sohal *et al.*, 1968). The SIRS and coagulation pathways interact to cause multi-organ system failure and the progression from heat stress to heat stroke and death (Leon and Helwig, 2010).

To extrapolate this heat stroke model to horses, it is well documented that horses are susceptible to the effects of endotoxin (Carroll *et al.*, 1965; Moore, 2001) and suffer from a similar endotoxaemic syndrome to that seen in humans, with high morbidity and mortality rates (Bryant *et al.*, 2007). In a most interesting study Donovan and colleagues (2007), using a high speed treadmill, exercised horses to absolute fatigue and found that the brief but strenuous exercise induced endotoxaemia and a systemic inflammatory response characterized by elevations in cytokines and prostaglandin $F_2\alpha$ and that these elevated concentrations persisted for two hours. Other researchers (Baker *et al.*, 1988; Barton *et al.*, 2003) have reported similar findings in race and endurance horses. These studies support the argument that the heat stroke model as described in man, characterized by gut-driven endotoxaemia and consequent inflammatory cascade, almost certainly pertains to the horse.

From the pathophysiological model – 3 critical points

Firstly, the gut is the origin of the SIRS and endotoxin is the key driver. The most common clinical findings in horses presumed to be endotoxaemic are an alteration of the mucous membranes to a hyperaemic or 'lolly pink' appearance with a slow capillary refill time, and a substantial elevation in heart and respiratory rates. Once heat stressed horses reach level 3 (see Table 1), they invariably exhibit these changes.

The second point is that as EHI syndromes become more severe, normalizing the body temperature alone may not be sufficient because the inflammatory cascade and concomitant effects as described have already been initiated and are progressing. Therefore, in addition to cooling it is necessary to provide therapy to modulate SIRS responses. There is good evidence that the use of a non-steroidal anti-inflammatory drug such as flunixin meglumine has a key role in the treatment of horses with EHI, and in the author's view, the earlier the better. As stated by Moore (2001), the non-steroidal anti-inflammatory drugs (NSAIDs) and specifically flunixin have been the mainstay for the treatment of endotoxaemic horses for at least two decades and the results of comparative studies clearly indicate the value of flunixin in preventing the endotoxin-induced synthesis of cytokines, prostaglandins and thromboxane which produce many of the clinical signs of endotoxaemia in horses (Moore *et al.*, 1986; Semrad *et al.*, 1987; Bottoms *et al.*, 1981). In the author's experience, horses with EHI administered flunixin at therapeutic dose rates improve clinically within ten to twenty minutes.

The third critical point is an observation and hypothesis that in the thoroughbred racehorse dehydration is not a driver of EHI but rather an independent risk factor[1]. It is acknowledged that horses presented on race day which have travelled long distances in the heat and sweated profusely, or have had water withheld because of particular training practices will be at higher risk, but in the author's experience dehydration is not always the determining factor for EHI. This is in contradistinction to the endurance horse where dehydration

Back to TOC page

is a key driver of the exhausted horse syndrome (McCutcheon and Geor, 2004; Hodgson, 2014). There is considerable individual variation amongst horses in the degree of sweating and consequent fluid loss and there are many other factors, such as genetic predisposition, temperament, acclimatization to hot weather, ambient levels of temperature and humidity, training schedule, fitness, race duration and intensity, and individual motivation of each horse to race, which all play a role in determining thermoregulatory dysfunction. Irrespective however of whether dehydration is a primary or secondary factor, management of dehydration must be included as part of the treatment protocol.

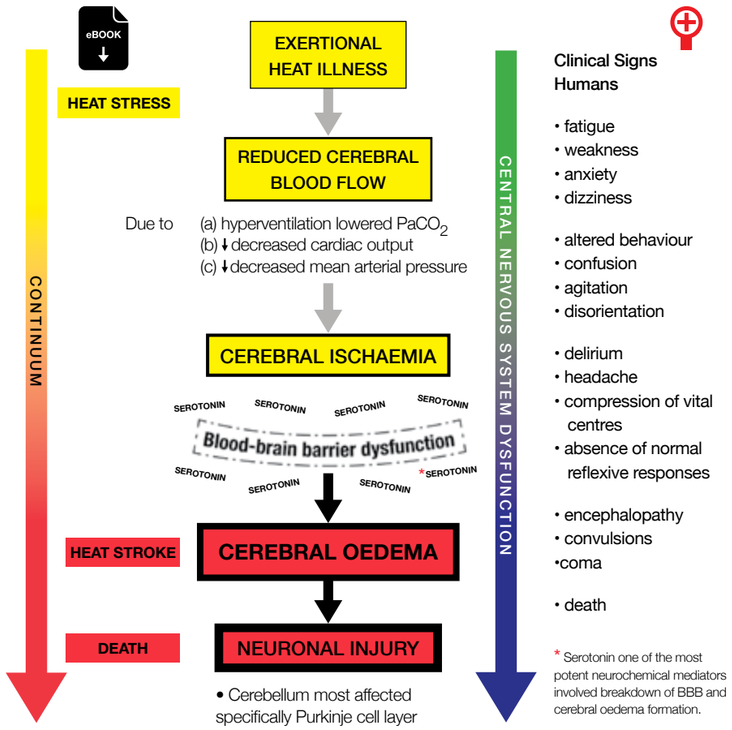
Central Nervous System Dysfunction Rationale for Treatment

The most challenging aspect of EHI syndromes in thoroughbred racehorses from a management aspect is the emerging symptoms of central nervous system dysfunction and the risk this poses to the people trying to treat these horses.

Cerebral pathophysiology and pathology

It is well documented that the human brain, compared with other organs, is especially vulnerable to hyperthermia, and the severity of the injury depends on the level and duration of overheating (Nielsen and Nybo, 2003). In humans, hallmark signs of the progression of heat related illness include alterations to mental status such as dizziness, confusion, delirium, combativeness, collapse, seizures and coma (Nybo, 2007). The pathophysiological changes (see Fig. 6) responsible for this symptomatology are, firstly, reduction in cerebral blood flow leading to cerebral ischaemia, and changes to blood-brain-barrier permeability allowing leakage of serum proteins, resulting in vasogenic brain oedema (Sharma and Hoopes, 2003). The latter is crucial in determining the extent of cell injury and consequent brain pathology because swelling of the brain within the rigid cranium has serious consequences. It is associated in humans with severe headache, the absence of normal reflexive responses, and alterations to consciousness (Yaqub and Al Deeb, 1998) and the associated pathological picture is one of neuronal degeneration, particularly in the cerebellum where the Purkinje cell layer is most affected (Leon and Helwig, 2010; Binkley *et al.*, 2002). It is worthy of note that despite rapid cooling, about 30% of human patients in the heat stroke category experience permanent neurological impairments that may be related to cerebellar atrophy and infarcts (Argaud *et al.*, 2007; Dematte *et al.*, 1998).

Figure 6. Postulated central nervous system pathophysiology after Sharma and Hoopes (2003)



Therapies – glucocorticoids

Treatments that address the central nervous system dysfunction include the use of therapeutic doses of glucocorticoids such as dexamethasone which has been shown to be beneficial in the treatment of brain and spinal cord injury in man, experimental cerebral ischaemia in animals and cerebral injury and trauma in horses (Hall, 1992; Behrmann *et al.,* 1994; Feary *et al.*, 2007; Reed, 1994). More recently Liu and colleagues (2000) experimentally investigated whether intravenous dexamethasone could protect against the heatstroke-induced cerebral ischaemia and neuronal damage in the rat heat stroke model. They used dexamethasone either before heat exposure or 80 minutes after the start of heat exposure and found dexamethasone reduced the heatstroke-induced arterial hypotension, the elevated interleukin levels, cerebral ischemia and neuronal degeneration, and resulted in prolonged survival. Administration of the drug before heat exposure rather than later gave superior results. The authors concluded that dexamethasone was an important modulator of the cerebrovascular and cytokine responses and thereby provided neuroprotective effects in the rat heat stroke model that they employed.

Synthetic glucocorticoids such as dexamethasone have potent anti-inflammatory and immunosuppressive effects that are widely used in the treatment of inflammatory disorders. There are general effects such as stabilization of cellular and lysosomal membranes and decreasing vascular permeability, as well as more specific effects aimed at modulation of the key chemical mediators of the inflammatory cascade (Amsterdam *et al.*, 2002; Zuckerman *et al.,* 1999; Simpson, 1990). Beneficial effects have been shown in the treatment of many inflammatory diseases, acute allergic conditions and endotoxic shock in the horse (Frauenfelder *et al.*, 1982; Lane *et al.*, 1990). In view of this dual action of dexamethasone, firstly in suppression of the inflammatory cascade and secondly in its neuroprotective role in the rat heat stroke scenario, there would appear to be good evidence for its use in the EHI syndrome in thoroughbred race horses. The key, however, is to use this drug as early as possible, a guideline supported by many previous findings (Whitehouse, 2011; Liu *et al.*, 2000).

Therapies – detomidine

As the severity of the EHI syndrome increases so do the manifestations of central nervous system dysfunction, to such an extent that horses presenting at Levels 3 to 4 cannot be cooled because they pose such a risk to treatment personnel. To overcome this, the author has over the years used sedatives such as xylazine or detomidine dosed to effect in managing the adverse nervous system signs. Clinically it has been evident that detomidine was far superior to xylazine and there appeared to be no deleterious side effects with its use in EHI horses. The fact is, however, that most horses received combination therapies such as efficient cooling, flunixin, dexamethasone and detomidine, which confounds the ability to determine the success of individual therapies. Critics of the use of detomidine in EHI horses cite the adverse effects on the cardiovascular system: bradycardia, reductions in cardiac output and hypertension due to peripheral vasoconstriction, then later hypotension (Sarazan *et al.*, 1989), all of which would act to limit the heat transfer process. However, horse and personnel welfare is an absolute priority, and in the author's opinion this drug has been instrumental in saving people and horses from injury.

The alpha-2 adrenoreceptor agonists are represented by xylazine, detomidine, medetomidine and dexmedetomidine. The first two are widely used in the clinical equine arena whilst the latter two are approved for use in dogs and cats. Detomidine provides reliable dose-related sedative and analgesic effects in horses with a rapid onset of action but of longer duration than xylazine (Clarke and Taylor, 1986; Vamio, 1983).

It is beyond the scope of this paper to review the physiology of alpha-2 adrenoreceptors but briefly they are located in the central nervous system and virtually every peripheral tissue. The alpha-2 agonists xylazine, detomidine medetomidine and dexmedetomidine stimulate presynaptic and postsynaptic alpha-2 adrenoreceptors in the CNS, resulting in decreased levels of norepinephrine and dopamine and producing the clinical effects of sedation, analgesia and muscle relation which is the basis of their therapeutic efficacy. These alpha-2 agonists are selective but can also activate alpha-1 receptors to a small extent which may play a part in clinical effects but only activation of alpha-2 adrenoreceptors produces sedation. At clinical doses the more selective a drug is toward the alpha-2 adrenoreceptor the more potent it is as a sedative. The ratio of alpha-2 to alpha-1 selectivity has been classified as: medetomidine (1620:1), detomidine (260:1), and xylazine (160:1), (Virtanen and MacDonald, 1985; Virtanen *et al.*, 1988; Virtanen and Nyman, 1985.)

An in-depth study (MacDonald *et al.*, 1988) of the neurochemical effects of medetomidine (a methylated derivative of detomidine) found that it depressed the turnover of noradrenaline and dopamine, and also significantly lowered serotonin levels. In view of this, it is suggested that detomidine might also cause some reduction in serotonin level. This is relevant because Sharma and Dey (1986) have implicated elevated serotonin level as a key driver in the cerebral pathophysiology associated with the heat stress/heat stroke progression. It has been well documented that serotonin is one of the most powerful vasoactive amines, capable of inducing vasoconstriction of cerebral vessels, impairing the integrity of the blood-brain barrier, increasing cerebral vessel permeability and leading directly to cerebral oedema and neuronal injury (Winkler *et al.*, 1995). These findings were supported by Kao and Lin (1996), who reported that when the cerebral serotonin system was antagonized experimentally in rats, heatstroke-induced ischaemic damage to the brain was reduced and the rats had increased survival times. More recently, Sharman and Hoopes (2003) used several animal models to study the effects of hyperthermia on chemical mediators within the CNS, and their findings also incriminated serotonin as one of the most active and potent neurochemical mediators in the pathophysiological changes to cerebral function. It may therefore be conjectured that detomidine might not only sedate horses with substantial EHI symptomatology but also provide clinical improvement by decreasing serotonin level to some extent and thereby disabling the deleterious progression of cerebral pathophysiology.

VIEW THE FILM CLIP: A graphic illustration of Level 2 'HOT' horses + irritability heat stress, which captures the essence of this perspective, is available here: **http://youtu.be/Sf04OTwjQPY**

[1]The Australian context for incidents of heat stress in racehorses may be quite different from that prevailing in the United States of America. The pre-race use of the diuretic drug furosemide (Lasix) is banned in Australia because it is classified as a "prohibited substance". In the USA however competing horses are routinely administered 350 to 500 milligrams of Lasix by intravenous injection four hours before post time in an attempt to control exercise induced pulmonary haemorrhage (EIPH). Although the effects of the drug are short-lived it will initiate a diuresis that may cause varying degrees of dehydration in individual animals. Under these circumstances dehydration may become a primary driver for heat stress and necessitate that treatment protocols include intravenous fluid therapy at all levels rather than just levels 3 and 4 as described in this paper.

Conclusion

The key issue concerning EHI in thoroughbred racehorses is its early recognition and prompt treatment because it is a genuine medical emergency. It is important to understand that the various stages are located on a continuum, with the milder stages of heat stress progressing toward heat stroke and death if that progression is not halted. Veterinary intervention on race day needs to be pro-active and involves rapid cooling techniques as described, the aim being to lower the animal's core body temperature within 30 minutes. There is overwhelming evidence that external saturation with ice cold water is the superior cooling modality. All stages of EHI require rapid and efficient cooling.

The driver of EHI syndromes is endotoxin released from a gut compromised by underperfusion following redistribution of a finite cardiac output. Endotoxaemia drives the inflammatory cascade, and cooling alone, at the later stages of EHI may not result in reversal or suppression of this pathophysiological progression, so that immune modulating drugs such as flunixin are considered essential. Synthetic glucocorticoids represented by dexamethasone are also indicated because they not only stabilize cell membranes and leaky capillary endothelium which is a direct effect of heat toxicity but also have been shown to possess neuro-protective effects. Finally, it is emphasized that dealing with heat-stressed horses can be extremely dangerous. They are apt to injure themselves and those trying to treat them and for effective restraint and sedation detomidine is preferred. Interestingly, there is some evidence that detomidine may decrease the level of serotonin in the brain, which has been incriminated as a driver of cerebral pathophysiology in the heat stroke model. This is obviously an area for further research.

The equine veterinarian should be ready for the occurrence of heat stress on any race day especially during the summer months, which means having ice always available and ready access to the necessary medications. Emergency medicine is all about being prepared and time is of the utmost importance for heat-affected animals. Staff in charge of horses at race meetings must be educated to recognize the behavior associated with heat stress in horses and be able to present the horse to the on-duty veterinarian as soon as possible. In an era when the welfare of racing animals is increasingly exposed to public scrutiny the racetrack veterinarian needs to be well informed and well prepared.

The author wishes to acknowledge all those people who have worked tirelessly to treat heat-stressed horses on race day and who have all contributed in some way to the observations in this article. They are Craig Suann, Melissa Kay, Sue McMaster, Kylie Smallwood, Carol Griffiths, Pat Cozzi and Natasha Pesce, and I also acknowledge the input from all of the fine racetrack veterinarians that we work with on a regular basis.

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Figure 6. 'HOT' horse with altered mentation toward depression and incoordination.

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DISCUSSION FORUM

EXERTIONAL HEAT ILLNESS IN THOROUGHBRED RACEHORSES:
OBSERVATIONS AND TREATMENT IN THE FIELD

C&T NO. 5377

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CVE Question 1:

Flunixin is safe and widely used in horses, whereas it's a very tricky drug in dogs and cats. Would other newer generation NSAIDs work in horses in this setting? It's just with gut ischaemia due to hyperthermia a COX2 selective NSAID may be safer for the gut, but maybe it would not work as well. Your comments?

The non-steroidal anti-inflammatory drugs (NSAIDs) inhibit prostaglandins, which are central to the generation of the deleterious effects of the inflammatory cascade.

Following an exogenous stimulus such as inflammation, or in my cases heat stress, cell membranes are damaged and phospholipid is liberated to form arachidonic acid. Cyclooxygenase (COX) is an enzyme that catalyses the conversion of arachidonic acid into prostaglandins, which play a significant role in both health and disease of the gastrointestinal tract, renal, skeletal and ocular systems. There are 2 distinct forms of cyclooxygenase isoenzymes, referred to as COX1 and COX2.

COX1 is often referred to as the 'housekeeping enzyme' and is believed to have an essential role in the maintenance of healthy tissues, including gastric mucosal protection, renal function and vascular homeostasis. Inhibition of COX1 often elicits gastrointestinal toxicity in animals and humans, manifested by bleeding, ulcerations, perforations and peritonitis. There appear, however, to be significant interspecies differences in both the level of COX1 and the ratio of COX1/COX2 expression in various tissues. This is most apparent in the gastrointestinal tract, so that extrapolation of toxicity effects between species from cats to dogs to horses may be misleading (Radi 2009). Apparently the cat is most sensitive, followed by the rat and dog, which may partly explain the overt sensitivity of these species to sub-therapeutic doses of the nonselective NSAIDs such as flunixin (Radi and Khan 2006). Toxic effects of non-selective NSAIDs have been reported in horses (Mackay et al., 1983), particularly for phenylbutazone. The literature has suggested, however, that providing the drug is used at clinical dose rates such problems are relatively uncommon. According to McIlwraith and colleagues (2001), flunixin administered at 3 times the recommended dose for 10 days resulted in few adverse clinical or biochemical signs; however, some cases of toxicity have been reported in ponies and foals.

The COX2 isoenzyme, on the other hand, is highly induced by pro-inflammatory mediators in the setting of inflammation, injury, and pain and inhibition of COX2 accounts for most and possibly all of the therapeutic effects of the non-selective NSAIDs. Consequently, there has been an intensive search to identify and develop drugs with selectivity for inhibition of COX2.

Flunixin meglumine is a non-selective COX inhibitor but according to Hsu and Kanthasamy (2013) this drug shows greater COX2 inhibitory effects than COX1 in horses, in contrast to dogs where flunixin appears to exhibit preferential COX1 inhibitory effects. Flunixin was introduced into equine practice in the 1970s and since then has gained widespread popularity in the treatment of musculo-skeletal disorders, for visceral pain with colics, and suppression of endotoxaemia, which has been well documented in the scientific literature. In a recent survey of 6,911 equine practitioners in America, Hubbell and colleagues (2010) reported that penylbutazone and flunixin were the most commonly used NSAIDs. Flunixin remains one of the most useful and popular drugs for the equine veterinarian.

Meloxicam is a NSAID with selective COX2 activity (Beretta et al., 2005), which may be a useful alternative to flunixin for the equine practitioner (Ilium Flunixil - 100mL $52; Norbrook Flunixon – 100mL $35). Meloxicam is marketed for horses as an intravenous injection at 2-3 times the price of flunixin, containing 20mg/mL (Randlab Meloxicam; Boehringer Metacam - 100mLs $135) with the recommended dose rates of

Back to TOC page

0.6 mg/kg or 3.0 mLs/100kg. Studies have shown that meloxicam achieves similar effects to flunixin in horses in terms of the biochemical parameters of recovery where there has been ischaemia-injured jejunum (Little et al., 2007), and more recently Naylor and colleagues (2013) compared flunixin with meloxicam in horses recovering from strangulating small intestinal lesions, concluding that the choice of NSAID did not appear to affect major clinical outcomes. Although more information is probably required, there is no doubt that meloxicam is emerging as a viable alternative to flunixin. Glucocorticoids and NSAIDs used concurrently is not recommended.

I have done a brief survey on the use of meloxicam. It is apparent that **the major racing veterinary practice uses meloxicam in preference to phenylbutazone because of the 3 day clearance time of the former** compared to the latter. There are very mixed reactions to this drug. Some believe it is not as good as phenylbutazone for musculoskeletal pain. In terms of its use as an alternative to flunixin for abdominal pain, sepsis and endotoxaemia there is very little support for meloxicam and flunixin remains the most popular. Although individual reactions were mixed, overall the conclusions were that it has not been embraced with the same enthusiasm that is apparent in small animal practice.

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CVE Question 2:

With dogs, simultaneous use of dexamethasone and flunixin is avoided for fear of stomach ulcers. Is simultaneous use also contraindicated in horses? Would you use flunixin for one grade, and dexamethasone for another?

When treating exertional heat stressed (EHS)/heat stroke horses with a combination of flunixin and dexamethasone we are using a single one-off treatment to avert a potentially life-threatening situation. Nevertheless, the ramifications of that treatment need to be considered and the horses monitored post-treatment for any adverse consequences. Concurrent therapy with corticosteroid/NSAID combinations should only be used when medically necessary and where it is considered that the benefits of treatment outweigh the potential risk.

If veterinarians are concerned about using both drugs a choice can be made based on the level of symptoms. Anecdotal evidence from trainers who have had horses severely affected (Level 4) suggests that some of these animals may never fully recover in terms of their neurological functioning. The case in people with heat stroke is similar; Sharma (2007) describes that those who survive a severe heat stroke episode are often crippled with lifetime disabilities and may exhibit profound cognitive, sensory and motor dysfunction akin to premature neurodegeneration.

If substantial central nervous system dysfunction is apparent in heat stressed horses, neuroprotection with dexamethasone is warranted. Detomidine may also be neuroprotective by reversing to some extent the serotonin-induced alteration to the blood-brain barrier and progression to cerebral oedema. Finadyne is considered essential to halt the progression of the inflammatory cascade although dexamethasone will also achieve this to some extent.

The author has treated many horses with the combination of dexamethasone and finadyne and is not aware of any adverse effects that would suggest the severity of gastrointestinal ulceration that has been described in small animals.

References

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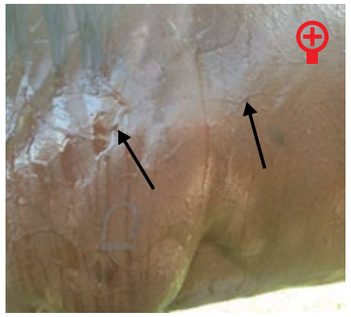

Figures 1 & 2. Cooling a hyperthermic horse. Note the network of dilated blood vessels in the skin.

Reference

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CVE Question 3:

When I treat dogs locked in cars, I tend to sedate them with low doses of acepromazine and an opioid, the rationale being that the peripheral vasodilatation will be helpful when you go on to use cold water for cooling. Is this protocol of any value in the horse? I realize that acepromazine alone may be insufficient sedation for controlling the horse as per your article.

To answer your question:-

1. Our horses with EHI are already vasodilated (they have raced) and are often sweating profusely although the sweat may not be evaporating because of the high levels of humidity. We have to pay particular attention to our cooling techniques so that we don't overcool and shut down the peripheral vasodilation. This requires constant monitoring of the skin temperature by touch, and observation of the network of dilated vessels of the skin – see photos.

2. In horses, acepromazine is not the best tranquillizer in terms of management, and can make horses more difficult to handle under some circumstances. For sedation in heat stress cases, xylazine or detomidine are far superior in terms of reliable manageability, and it's interesting to observe that even when these drugs are administered at the higher dose rates the EHI horses don't appear obviously sedated, i.e., head down and sedated stance. Might this be due to the serotonin effect in the brain?

3. Many of the physiological and biological responses differ between exercise-induced hyperthermia (my heat stressed horse) and passive hyperthermia (your dog locked in a car). Jimenez and colleagues (2007) experimentally put one group of people in a climatic chamber to reach a rectal temperature of 39°C in 120 minutes while a second group exercised on a treadmill at 65% VO2max (submaximal) in controlled conditions to achieve a rectal temperature of 39°C after 120 minutes. Among many parameters measured, they found substantial elevations of catecholamines, which they thought were responsible for marked mobilisation of blood leukocytes and leukocyte subsets, in the exercise group only. The major hormone released during passive heating was prolactin, and it is hypothesised that this different hormonal response may have a role in a different immune response from that seen in the exercise model. The most interesting finding was that plasma volume was better preserved during exercise than during passive heat exposure. So, you need to give more fluids to dogs locked in the car than I do to my horses with EHI!

CVE Question 4:

Finally, in dogs with heat stroke – cool IV fluids and ice water enemas are thought to be helpful for cooling the core. It's easier to give fluids fast to a dog than to a horse, but giving some cold fluid into the rectum after sedation might be possible?

Giving a rectal enema to a horse at the racetrack might be a bit frightening to say the least – even after sedation with detomidine. Personally, I feel that the potential risks would greatly outweigh the benefits. You must remember, it is not a practice environment – sometimes it is difficult to even give intravenous fluids at the races because of the logistics and the time constraints. There is a race every 35 minutes and on a hot day we might have waves of horses that need attention, or at least supervised cooling, after every race. People actually available to help are few and at country tracks, with only one vet to do everything, the situation becomes even worse.

A CHRONIC VIRAL DISEASE OF GOATS THAT WE NEED TO ERADICATE: WHAT DISEASE DOES THIS TO GOATS?

C&T NO. 5378

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Figure 1. Prior to contracting the disease.

Figure 2a.

Figure 2b.

There is NO treatment and NO vaccine.

It is mentioned in the National Goat Health Statement that should go with each National Vendor Declarations (NVD) and in the National Kid Rearing Plan.

But, it is not Johne's Disease nor gastro-intestinal parasitism (although wasting is a common sign and these goats could have these conditions as well because their resistance is reduced).

The key message to goat producers is NEVER feed pooled milk to goat kids.

NOTE: Look out for 2 more of Sandra's articles in our upcoming June 2014 Issue 275

Grateful thanks to both Scott Reid and Sandra – Scott for supplying the great goat image featured in our ebook which inspired Sandra to write these articles specifically for the C&T Series.

The disease is

CAPRINE ARTHRITIS ENCEPHALITIS (CAE)

CAE is caused by a slow virus which is a member of the retrovirus family (like HIV-AIDS). It is from the subgroup, lentivirus, the same as the sheep disease Maedi Visna (also called Ovine Progressive Pneumonia), which is exotic to Australia. MV/OPP and CAE are so similar that it is suggested both must be controlled at the same time for either eradication program to succeed. CAE viruses are attached to monocytes and macrophages. CAE can also be referred to as 'big knees', caprine retrovirus or caprine lentivirus.

Large numbers of viruses are in the inflamed brain, spinal cord, lung, joints, and mammary gland cells of CAE positive goats. Smaller numbers are in the uterus, lung, liver, spleen, lymph nodes, lining of the vessels of the brain, synovium, intestines, kidneys & thyroid.

Transmission is via bodily fluids. **Milk and colostrum are the main sources of infection.** Horizontal transmission between dry goats is less likely, but still possible. There is a very high risk if goats are milking or kidding. A single tiny intra-mammary dose can transmit CAE, so CAE positive goats should be milked last and milking machines well maintained. Overseas, sheep have acted as carriers.

The key message to goat producers is NEVER feed pooled milk to goat kids (unless it is pasteurised first).

Clinical signs take one of these following forms:

- Chronic Arthritis which starts as a peri-arthritis and progresses to deformed limbs and wasting
- 'Hard Udder' – udder feels like a smooth stone under the skin with only a small amount of milk produced
- Chronic interstitial pneumonia with wasting and difficulty breathing
- Nervous signs (generally in kids)

Clinical signs can be very slow to show up and initially they can be very mild e.g. just swollen carpus joints as shown in next photo. Signs increase with increased viral load in a herd.

Some, but not all Australian states, have CAE freedom accreditation schemes and goat herd owners should be encouraged to take part and only buy new animals from accredited herds.

Figure 3. Illustrates why CAE is sometimes referred to as 'Big knees'.

Milk and colostrum are the main sources of infection.

Further Information

Facebook page – Let's Eradicate CAE from Australian Goats see
www.facebook.com/EradicateCAEinGoats?ref=hl

National Goat Health Statement
www.animalhealthaustralia.com.au/wp-content/uploads/2011/04/GHS_form.pdf

National Kid Rearing Plan
www.animalhealthaustralia.com.au/national/kid/rearing/plan

Slideshare presentations on CAE
www.slideshare.net/SandraBaxendell

These US sites:

www.goatbiology.com/caereferences.html

www.dairygoatjournal.com/issues/90/90-1/cae_prevention_and_management.html

MAJOR WINNER!

The Major Prize Winner is entitled to a year's free membership to the CVE.

THE GRASS IS ALWAYS GREENER IN THE PULMONARY SIDE

C&T NO. 5379

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Mark (pictured above) with one of Tassie's endangered Wedge-tailed Eagles

Mark is a born and bred Brisbane boy who graduated from the University of Queensland in 2000. As a self confessed meteorological refugee, he fled the balmy sub-tropics for temperate Tasmania. Three years in mixed practice in the 'north-west' followed by the ubiquitous 2 year sojourn in the UK, led him further south to Hobart. Mark has been practicing in Kingston, just south of Hobart, for 8 years and his interests lie mainly in small animal medicine. Exploring Tassie's beautiful places with his family and running provides the yin to his veterinary yang.

'Jax' a 3-year-old male desexed Tonkinese indoor/outdoor cat presented to us in the middle of summer with acute onset of inappetance, lethargy and tachypnea. Physical examination was unremarkable except mild dehydration and high temperature (40°C). Tachypnea was not noted at examination despite the owners reporting it at home. My general approach to fever of unknown origin in the cat is that they are cat fight induced until proven otherwise. I administered sub cutaneous saline, a carprofen injection and sent Jax home with a 5 day course of amoxicillin/clavulanic acid tablets.

Jax represented 8 days later for a dry cough, weight loss, inappetance and tachypnea. He improved after the medications prescribed previously but never got back to normal. Physical examination was unremarkable (temperature was normal) except tachypnea of 60 breaths per minute with mild abdominal effort. Chest radiographs were taken and revealed a radio-opaque mass in the right side of the thorax (~50x20mm), some radiolucency caudally (possible pneumothorax) and some loss of contrast ventrally (see fig. 1 and 2). Image quality was not great due to a moving patient. A quick ultrasound of the right side thorax revealed no obvious pleural fluid and I could not visualise the mass. Pulse oximeter of the tongue revealed 88% Po_2 saturation.

Jax was sent to the local after hours emergency centre where he was placed on oxygen, given pain relief, IV fluids, mirtazapine and Clavulox/clindamycin. His oxygen saturation improved to 91% (off oxygen supplementation) during the night. Jax was anaemic with a PCV of 23.1. Now Jax was stable, a thorough chest ultrasound was planned.

Ultrasound revealed a 20x30mm mass on the right caudodorsal thorax. Milliary air bubbles in the mass suggested a lung based mass. IDEXX FNAB cytology revealed no microorganisms, no neoplastic cells, but reactive lymphocytes and haemosiderophages (macrophages with ingested red blood cells) indicating pathological bleeding and mixed inflammatory reaction.

Jax was going to need a thoracotomy, but before this I thought a chest CT and FIV/FeLV testing was prudent. Jax was retrovirus negative and his CT results revealed a bilateral pneumothorax, atelectasis of the right middle and caudal lung lobes with a RIGHT CAUDAL LOBAR PULMONARY BULLA. Enlarged pulmonary arteries with pulmonary hypertension suspected.

A thoracotomy and pneumonectomy was performed by a referral surgeon soon after. The right side middle, accessory and caudal lung lobes were removed due to consolidation/atelectasis. The cranial lobe was partially inflated (see CT images) and was left. A chest drain was placed and removed 48 hours after a good recovery.

Culture from the affected tissue grew a few colonies of *Actinobacter spp*. Histopathology showed pyogranulomatous pneumonia with plant material. It was unsure whether this was a grass seed or grass blade although the former seems much more likely. Jax went on appropriate antibiotics for 2 weeks. He recovered well

from his surgery and had chest radiographs 2 weeks later (see Fig. 5 and 6) which showed recovery and PCV 3 weeks post surgery which was normal.

The right side of the thorax in carnivores has ~ 60% of the total lung tissue (a cranial, middle, caudal and accessory lobe) whereas the left side has ~ 40% (a cranially and caudally divided cranial lobe and a caudal lobe). Speaking with Richard Malik, he commented that in veterinary literature there is good evidence of cats living on 40% of functioning lung tissue. Thus the entire right side or left side can be removed and enable survival (be it with a non-athletic patient)! Also with the possibility that remaining lung may 'expand' into the space deficit and become more efficient at gas transfer.

My lesson learned here is to radiograph all cats with any hint of tachypnea – especially if the owner has noted it at home. The threshold of 30 breaths per minute or greater should not be seen in a healthy non-stressed cat.

I would like to thank Chris Allfree, Sean Muir and Richard Malik for helping Jax and myself.

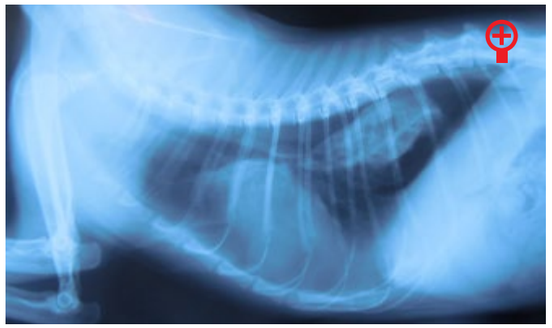

Figure 1: Left lateral radiograph prior to CT and ultrasound guided FNAB. Note radio-opaque mass (bullae) dorso-caudally.

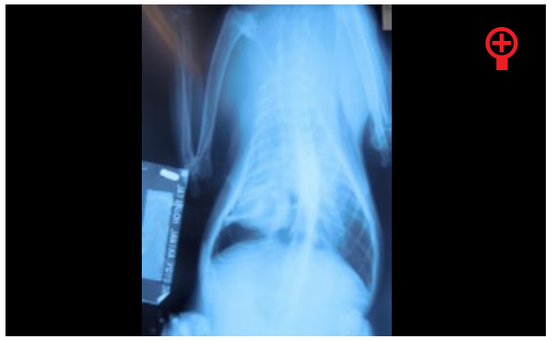

Figure 2: DV radiograph prior to CT and ultrasound guided FNAB. Note early pneumothorax signs (radiolucency) in the caudal right side thorax.

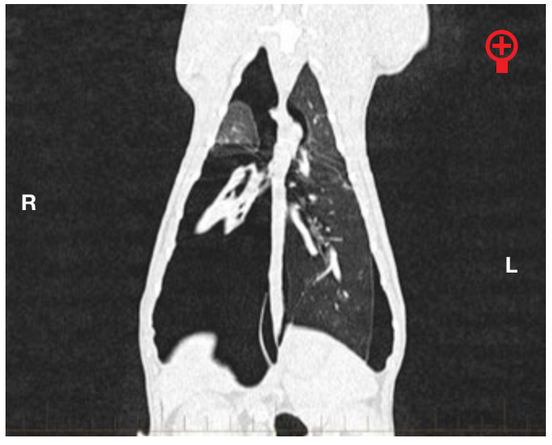

Figure 3: Thorax ventro-dorsal with contrast. 'Note the radio-opaque mass (pulmonary bulla) in the right side thorax with some functional cranial lung lobe and large pneumothorax. Mild pneumothorax seen on the left side as well caudally'.

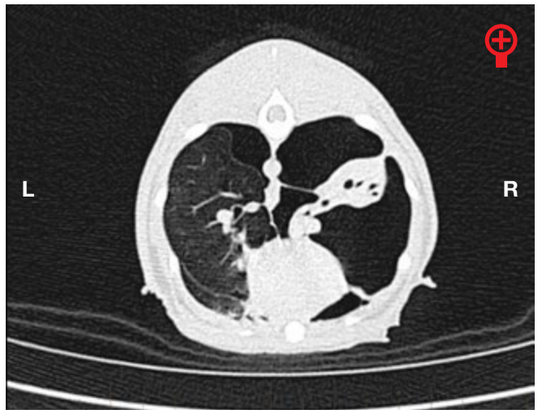

Figure 4: Thorax transverse with contrast. 'Again the radio-opaque mass (pulmonary bulla) can be seen in the dorsal right thorax (cardiac silhouette ventral) with associated pneumothorax'.

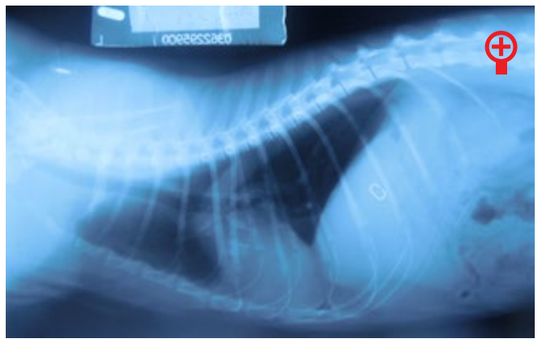

Figure 5: Left lateral radiograph 2 weeks post pneumonectomy

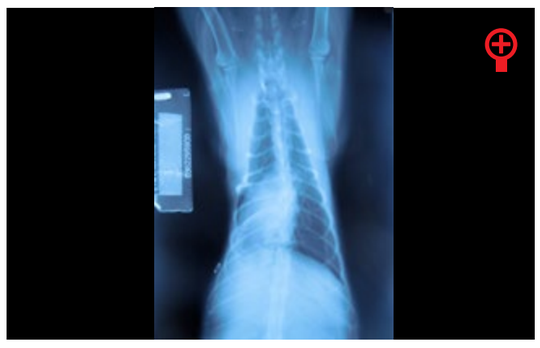

Figure 6: VD radiograph 2 weeks post pneumonectomy

CASE REPORT/ EXERCISE IN DIAGNOSTIC REASONING

FLEXOR CARPI ULNARIS TENDONOPATHY IN A WEIMERANER – NOT JUST A ONE-OFF THING!

C&T NO. 5380

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Elizabeth graduated with honours from the University of Sydney in 2007. She started working in a Sydney metropolitan small animal practice from 2007- 2011, where she was particularly involved with treating hyperthyroidism in cats using radioactive iodine therapy. She joined the Small Animal Specialist Hospital in 2011, completing a one year rotating internship, followed by a medicine internship and then commenced her residency in small animal internal medicine in January 2013. Elizabeth has also worked with the Department of Primary Industries during the Equine Influenza outbreak and with her local government as a member of the Companion Animal Advisory Committee.

ABSTRACT

An 8-year-old male neutered Weimeraner dog presented for a soft tissue swelling of the palmar aspect of the carpus of the left thoracic limb. Diagnostic investigations suggested the problem was attributable to flexor carpi ulnaris tendonopathy. The case was remarkably similar to that recently reported by Kuan et al (2007), although focal mineralization of the tendon detected radiographically and sonographically was an additional finding in this instance. There was little or no response to systemic treatment with meloxicam. The swelling responded immediately and completely to a topical formulation containing dmethyl-sulphoxide (DMSO) and a fluorinated corticosteroid, although the problem recurred again some months later after vigorous exercise, but again responded to the same treatment. It would seem flexor carpi ulnaris tendonopathy may be an entity in the Weimeraner breed as well as in racing Greyhounds subjected to heavy track work. Thus, tendonopathy may affect non-racing dogs subjected to repetitive percussive injury, but is easily managed using simple topical therapy and exercise restriction.

Key words: flexor carpi ulnaris, tendonopathy, Weimeraner, DMSO.

CASE REPORT

Clinical Investigation

An eight-year-old male desexed Weimeraner was presented for a focal swelling on the palmar aspect of the left thoracic limb. There was no lameness associated with the swelling and the dog was otherwise well. The swelling was immediately proximal to the accessory carpal bone on the caudal aspect of the limb, and appeared to affect the tendon of the flexor carpi ulnaris muscle (Fig. 1).

The affected area was firm on palpation, but not painful. The carpal joint had, perhaps, a slightly reduced range of motion (on flexion). The dog was sent home with instructions to enforce strict rest and to administer meloxicam (0.1 mg/kg orally with food sid)[1] for one week.

As the swelling did not improve with NSAID therapy (Fig. 2), the dog was admitted for radiographic and ultrasonographic studies. Dorsoventral and mediolateral radiographs of the carpi were obtained, and demonstrated a small focal radiopaque lesion, surrounded by soft tissue swelling, on the caudal aspect of the carpus (Fig. 3).

An ultrasound examination was performed to further characterise the cause of the radiopaque area within the soft tissue swelling (Fig. 4). There was loss of the normal pattern of linear, parallel collagen fibres within the flexor carpi ulnaris tendon, the architecture being replaced by a disorganised mixture of hyperechoic and hypoechoic densities possibly reflecting haemorrhage and/or oedema. A focal fusiform lesion (approx. 5 mm x 2 mm) was evident in the middle of the tendon (Fig. 4a and 4b – black arrows), with distal acoustic shadowing (Fig. 4a and 4b – yellow arrows). Fine needle aspiration of the swelling was performed but there was poor exfoliation and the specimen obtained was non-diagnostic.

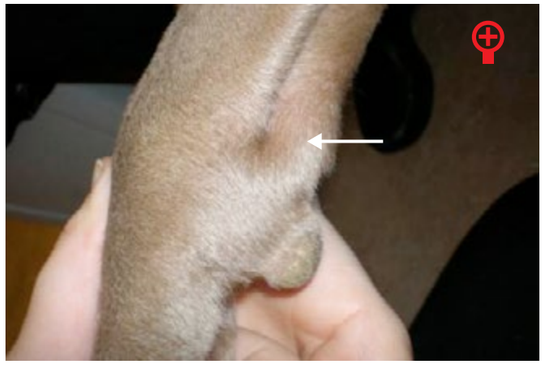

Figure 1. The left carpal region of an eight-year-old male Weimeraner at first presentation. Note the swelling of the tendon of insertion of the flexor carp ulnaris muscle immediately proximal to the accessory carpal bone (arrow).

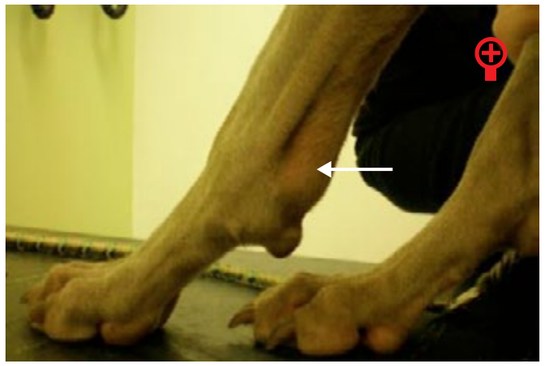

Figure 2. The appearance of the affected limb after rest and meloxicam therapy. The swelling of the flexor carpi ulnaris tendon (arrow) remains obvious.

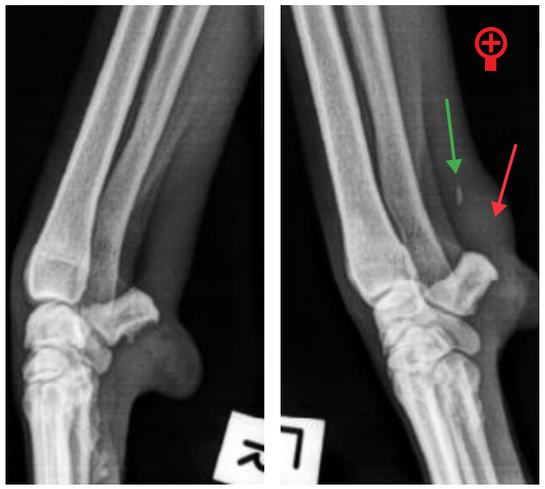

Figure 3. Radiographs of the right (normal) and left (abnormal) and right carpus; mediolateral projections. There is an obvious soft tissue swelling caudal to the distal ulna, and proximal to the accessory carpal bone (red arrow). Note the focal fusiform area of mineralisation (green arrow) in the middle of the swollen soft tissue density.

Based on the physical findings (swelling of flexor carpi ulnaris tendon), radiographic and sonographic findings, we made a diagnosis of traumatic tendonopathy. Based on the experiences of the remarkably similar case recently reported by Sue Kuan and colleagues (2007) in the *Australian Veterinary Journal*, we elected to use a topical 'roll-on' formulation containing flumethasone (0.05mg/g) and dimethyl-sulfoxide (600mg/g)[2] and continuation of strict rest. Within two applications, the swelling had disappeared. Topical therapy was continued for one week in total. The dog remained well for several months, although the problem recurred in the same location after a bout of vigorous exercise, this time associated with mild lameness. Again, application of the roll-on DMSO/corticoid formulation rapidly resulted in clinical improvement.

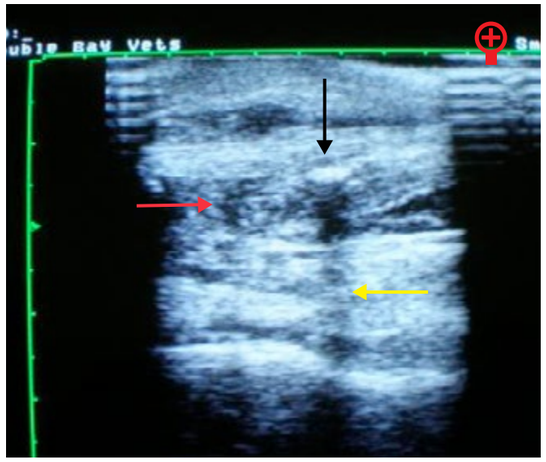

Figure 4a.

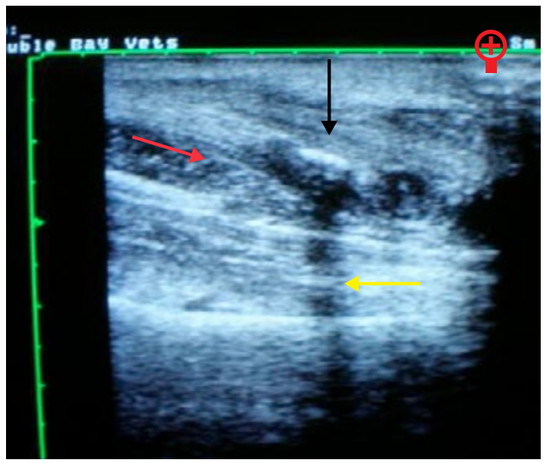

Figure 4b. Sonographic images obtained of the soft tissue swelling using a 10 MHz linear array transducer. Note the disorganised collagen bundles (red arrow) and the fusiform mineralised density (black arrow) casting an acoustic shadow (yellow arrow).

[1]Metacam, Boehringer-Ingelheim

[2]Flucort Domoso Roll-on®, Jurox

DISCUSSION

The decision making process involved in the diagnosis of disease very much involves the three 'Ds': detection, description and deduction. The first two rely heavily on collection of data through the senses (perception), whereas **deduction** relies on the organizational process whereby data is collated within the brain (Eva *et al* 2005).

This case was presented for investigation of a soft tissue swelling affecting the flexor carpi ulnaris tendon in one limb of an aged male Weimeraner. With the benefit of hindsight, this was an easy 'pattern recognition' diagnosis to make, because the 'illness script' for flexor carpi ulnaris tendonopathy (Kuan et al 2007) is especially characteristic (Gladwell 2005, Sanders 2009). Indeed, the inclusion of Chris Tan in the list of the authors was contingent on his ability to recall this particular 'illness script' when we sent him a photo of the patient's leg as an e-mail attachment! No doubt Graeme Allan would have likewise been able to diagnose the condition in the 'blink of an eye' when provided with a photo of the patient, a radiograph of the limb, or a sonogram of the affected tendon (radiologists can use pattern recognition, often only using shades of grey!) (Gladwell 2005).

During the initial investigation of this patient, the primary clinicians (Thrift and Malik) were not aware of this entity. Neither of us has a strong interest in orthopaedic condition of dogs, and although we likely cited Dr Kuan's paper in the AVJ, it didn't 'stick' in our brains. Stated another way – we didn't have an accessible 'illness script' for this somewhat obscure musculoskeletal condition. So instead, we initially had to rely on a problem-orientated approach using 'hypothetical-deductive reasoning'. Our differential diagnosis for the firm swelling was a degenerative or traumatic disorder (e.g. tendonopathy, hematoma), focal abscess, foreign body granuloma, neoplasm (soft tissue sarcoma, mast cell tumour, etc). To be honest, tendonopathy wasn't really on our list! Indeed, once we detected the mineralized density in the centre of the anatomic region affected, our principal reason for using sonography was to make sure there was not a foreign body granuloma present, or a localised abscess around a radio-opaque foreign body.[3]

It was just as well we sought expert advice about this case following the initial 'work-up', because after palpation, radiology, sonology and needle aspiration, further avenues of investigation might have proved to be extremely expensive (helical computed tomography, magnetic resonance imaging, scintigraphy) or invasive (exploration and biopsy).

Truthfully, had the primary clinicians been aware of this condition when the dog was first examined, it is quite likely that radiography, ultrasonography and fine needle aspirate biopsy might have been circumvented, and instead the patient may have been given a trial of the topical DMSO/corticoid preparation. This would have saved the owner a great deal of money. The lesson to be learnt here is that quick consultation with an expert early in the work-up can improve the efficiency and speed of the diagnostic process. The value of consulting an expert clinician when confronted by a case a bit out of the ordinary is therefore emphasised. This might involve a phone call, or an e-mail, rather than a formal referral consultation.

Flexor carpi tendonopathy has been well documented in racing Greyhounds, although remarkably, most of the information is in conference proceedings and textbook chapters, rather than in peer-reviewed journal articles. This is a limitation of the use of evidence-based medicine (EBM) in veterinary medicine – much of the best information for certain conditions appears in sources at the bottom of the EBM pyramid! Presumably the tendonopathy develops as a consequence of the increased stress placed on this tendon with intense repetitive activity (Denny, 2004). The recent report of this tendonopathy in a Weimeraner, (Kuan et al. 2007), suggests that non-racing dogs subjected to repetitive percussive trauma during normal but vigorous exercise can also develop this condition.

This case differs from that of Kuan *et al* (2007) in a number of respects. In our patient, the swelling did not result in significant lameness. In relation to therapy, a padded fibreglass splint was not applied in this case to immobilize the limb as a preliminary step in therapy. Denny (2004) suggests that complete immobilisation in the four to six week period after tendon damage is vital for tendon healing as movement significantly impacts on the development of fibroplasia and fibrous union. However, in the case documented by Kuan *et al* (2007), lameness returned immediately after the splint was removed, but there was subsequently a remarkably prompt and complete response to topical DMSO/corticoid roll-on. Our patient likewise improved astonishingly well after topical therapy, suggesting immobilisation is not necessary, provided the dog has restricted exercise. The rationale of using the DMSO/flumethasone roll-on formulation, is that the DMSO 'carries' the corticoid rapidly through the skin and into the soft tissues in and around the damaged tendon.

It is interesting that in both this case report and the report by Kuan *et al* (2007), the two respective patients were members of the Weimeraner breed, a pedigree dog with an energetic and athletic temperament, and biomechanically sound conformation. Additional anecdotal information on flexor carpi tendonopathy was found by searching archived discussion forums on the Veterinary Information Network (VIN), which documented two cases: one in a Labrador retriever and another in a Weimeraner with thoracic limb lameness and characteristic soft tissue swelling in the area consistent with the flexor carpi ulnaris tendon.

This case report confirms the previous finding by Kuan *et al*. (2007) that this tendonopathy occurs in breeds other than racing Greyhounds and suggests that this condition may be more common in practice than the current peer-reviewed literature would indicate. In an attempt to gather more information on the prevalence of this problem in this and other breeds, a questionnaire is presented at the end of this article.

[3]The concept of mineralized tendonopathy did not occur to us until we had re-read Sue Kuan's paper after email correspondence with Chris Tan, although we were aware of the calcifying tendonopathy affecting the biceps muscle tendon of large-breed dogs.

SURVEY

We are interested in determining the commonness of flexor carpi ulnaris tendonopathy in non-Greyhound breeds. Please complete each question below if you have observed a dog present with signs consistent with Flexor Carpi Ulnaris tendonopathy (FCUT).

Veterinarian's name, Clinic and phone number or e-mail address:

The breed of dog(s) affected:

Was the left front leg, right front leg, or BOTH front legs affected?

L / R / both (circle)

Was diagnostic imaging (radiography/ultrasonography/CT/MR) used to confirm or support your diagnosis?

Yes / No (circle)

If yes, please discuss the method used and briefly describe your findings:

Was surgery or needle aspirates performed to collect a biopsy specimen?

Yes / No (circle)

If yes, please indicate the findings:

Please discuss any treatments (including strict rest, splints or medication) and whether or not they achieved clinical resolution:

Please Fax to 02 9363 1238 or email to elizabethralph85@gmail.com
marked: Attention Elizabeth Ralph

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Acknowledgements

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FELINE TIPS

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DUAL USE AIRMUZZLE/ OXYGEN CAGE

The airmuzzle is pretty self-explanatory once you have one in your hands and has an adaptor that turns it into an oxygen mask.

The adaptor bit should be removed when using is as a muzzle, as the cats are easier to monitor if you can see them.

The key is – take the front 'oxygen attachment' section out, so it is a see-through system. Open the back section wide (it goes very wide) and make sure the velcro is attached only on the purple section – so you can connect the back section together quickly. Obviously you have to stop the cat going backwards, but then most cats will be so busy looking at the contraption that it is pretty easy to slip over their heads (back section first). Quickly velcro to neck size (small). There's no chance of choking the cat. Then everyone has only to watch for claws. Wrap cat if needed.

The unit is very light, easy to clean and does not jam, even when you are in a bit of a rush. Try it on a nice, compliant cat first. Because they can breathe, see, and make noises, most cats give up the fight.

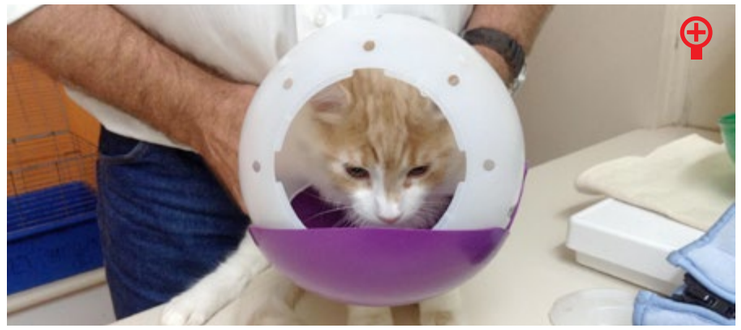
Saves fingers, time and deep bites!

I bought mine direct from USA (about $130 landed) and there are cheaper 'home use' versions. (Unfortunately I don't think they're available here in Australia yet.) It is designed to be turned into an 'oxygen cage' – the 1cm hole in the front would have some endotracheal tube fitting that would work, along with tape!

Figure 1. Airmuzzle – Front – complete with Oxygen adaptor in front

Figure 2. Airmuzzle – back (note: velcro attachments for sizing)

Figure 3. Airmuzzle – first placed on cat



Figures 3 & 4. Airmuzzle in working position

I SPEND MY LIFE TRYING NOT TO PUT E-COLLARS ON CATS (I ONLY DO IT EVERY 10 YEARS OR SO...)

So, the Air Muzzle is for grooming cats/ restraining them (takes the fear out of handling them and everyone calms down). It's easy to slip on the cat's head even when it is being feisty. At least the first time – haven't had a chance to retry it on the same cat!

The other forms of Elizabethan-collar (E-collar) are to try to reduce the stress inherent in stopping a cat from licking itself. Licking releases endorphins in a cat, and some research at the Waltham Centre showed that just putting an E-collar on a cat was enough to induce stress-related pruritis. E-collars are NEVER the answer for itching cats, and only a very temporary answer for surgery wound protection.

AND SURGICAL WRAPS AND COATS

The surgical wrap and little coat were mainly because the dermatologists have identified that atopic itching is reduced by removing skin contact with allergens (airborne especially). It is surprising what a cat will tolerate wearing. The coat needs to come off intermittently to allow the cat to groom itself (and obviously the cat should be well-washed before putting it on!), but they will just lick the coat rather than pull it off if they are comfortable.

The Siamese in the first pictures, of course, defied all the rules – pulled out stitches AND staples out of the surgical wound along his thorax (lipoma removal – should not have bothered) even though he only had lower canines left after a major dental. And proceeded to destroy the wrap with the same lower canine, despite the puff-collar! All the while eating happily unless his tooth got caught so he could not eat.

Cats…

These are cheap and come in packs of 6. Quite nice for little dogs as well, I'd guess.

I removed a lipoma from this cat's side – then wished I hadn't. Even though he only has 3 canine teeth, he chewed out the stitches (Horizontal mattress sutures, knots on distal side of wound!)

And then chewed out the staples! I do a lot of stapling – quick and easy and no more painful than local. So we had to resort to this – the white body wrap is a surgical wrap (stretchy bodysuit with armholes, velcro to hold it around, and I used Comfort wrap on top of it. And a 'puff colar' – blow air into a little plastic tyre tube inside the blue outer to make it fit. I think the collar attachment is superfluous, but strapped it on anyway!

So far so good!

Figure 1. From the Front

Figure 2. From the back – not as sturdy and does not enclose a cat's face so well, but probably still viable as a biting deterrent.

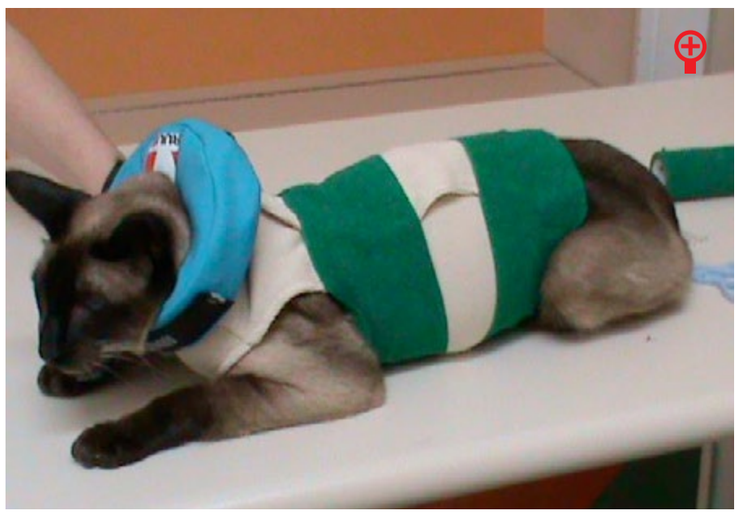


Figure 3. The patient in a surgical white body wrap (stretchy bodysuit with armholes and velcro to hold it around the torso) and Comfort wrap layered over that, with the blue 'puff collar'.

COMPULSORY USE OF IN-CLINIC PET MUZZLES AND CHANGING THE VISUAL FOR THE CLIENT

Aine Seavers [a]
Kim Kendall
(detailed above)

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Given the drive to create cat-friendly and dog-friendly clinic items, plus the law in some states requiring the use of muzzles in our patients, I wondered if anyone knew of or thought whether more 'human visually friendly' dog and cat muzzles were useful/available or could be designed? I ask because of a fairly active discussion on a vet global e-list I am on where even some vets struggle with the concept of using a muzzle and to my horror and sadness, seem to accept themselves and their staff being bitten as a badge of honour…

As a way forward, I was intrigued when 2 good colleagues revealed they ask for a 'nose warmer' or 'party hat' when asking the nurse to get a muzzle – a clever change of concept. I tried the 'nose warmer' term on a few clients and it went down well.

To develop that, perhaps the makers of say the Mikki leather and the plastic cloth type muzzles could consider making muzzles other than in black – perhaps bright pink and calming green, or some cute clouds and field scenes (no pics of other animals with big eyes staring back up at the dog). This would really help de-stress the owner and, in changing the visual, change the mood in the room. And make the consultation overall safer and less stressful for pet, vet and owner.

The pet is not being 'punished' or reprimanded as many owners think and you can see a few get quite offended by the muzzle use. I explain legality and the calming effect of the muzzle on the acupuncture de-stress points plus I pre-spray my leather muzzles with Adaptil or plastic cat muzzles with Feliway at the beginning of the day and top up if we need to which does help as well but the black muzzle visual is still a negative visual.

Reply from Kim Kendall

catclinic@catclinic.com.au

I didn't know it was compulsory to muzzle dogs... or anything?

The 'air muzzle' is quite useful for cats – groomers use it a lot. The cat pretty soon figures out it can't bite, but you can still see the cat's face. I rarely use anything – and the 'burrito wrap' as Dr Sophia Yin calls it is a defacto muzzle: *www.drsophiayin.com/lsh*

FMI, go to: *www.smartpractice.com*

EYELID STAPLING FOR CORNEAL LESIONS

I use local anaesthetic into the eye, debride with cotton bud, pack with Orbenin (CATtle) Eye Ointment, then staple close. After checking 3 days later, I decided that this cat needed restapling.

I have done several now and the cats are remarkable unreactive (even Burmese leave their eyelids alone).

There is no need for an e-collar – just pinch up the eyelids between your fingers, staple with a 35W staple and done. Removal is equally simple.

I warn the owner that the cat looks like Frankenstein temporarily but will be fine.

Figure 7. Unstapled

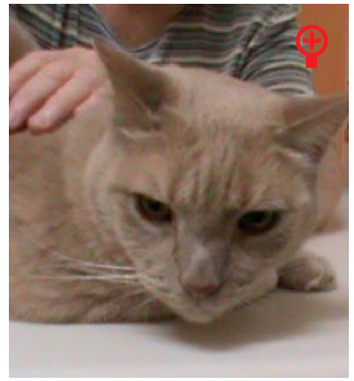

Figure 1. Unhappy cat (first visit)

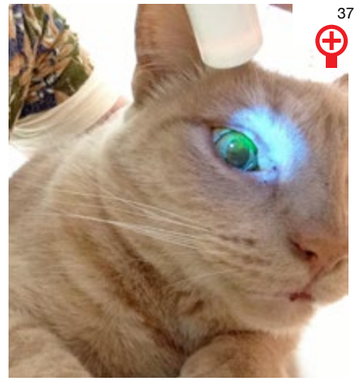

Figure 2. Fluroscein Positive

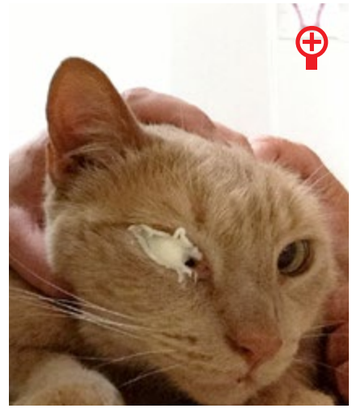

Figure 3. Cornea debrided, ointment applied

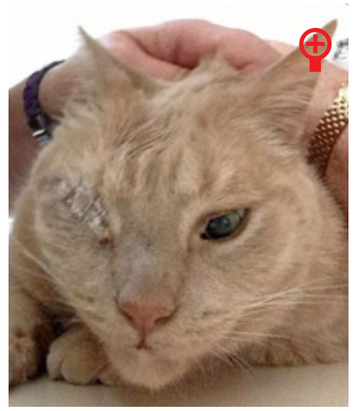

Figure 4. First stapling

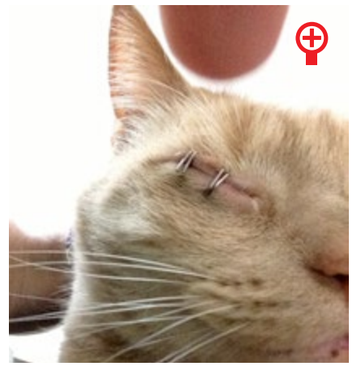

Figure 5. Stapled and clean

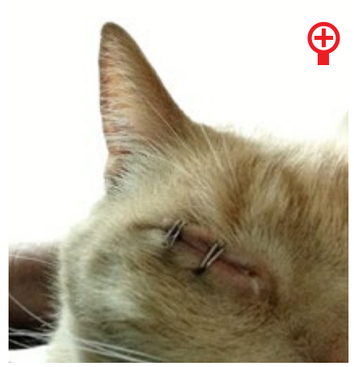

Figure 6. Revisited

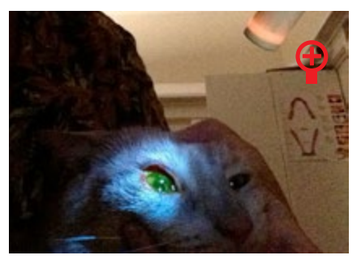

Figure 8. Fluoroscin positive again

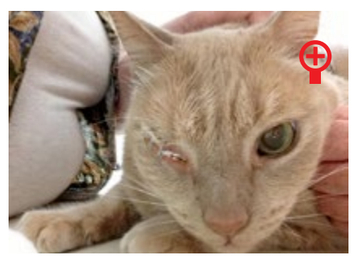

Figure 9. Restapled – worked this time

WINNER OF BEST FILM CLIP

LOCALISED TETANUS IN A BENGAL CAT

C&T NO. 5382

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BVSc (Year V, University of Sydney)

Chris McClelland
BVSc (Hons)

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Go to our eBook to view the video

Tetanus Film Clip

Clinical Presentation and History

A 3-year-old, female spayed Bengal cat had gone missing for about a week before her owners found her back home with her right forelimb caught in her flea collar. The owners noticed a large wound under the cat's right forelimb where the flea collar was caught and presented her to Hamilton Veterinary Clinic on 8 May 2013.

Initial Physical Examination Findings: 8 May 2013

On presentation, the cat was agitated and slightly aggressive, making a thorough examination difficult. Based on distance examination, she was bright, alert, responsive and still had a good body condition score (4/9). Her right forelimb was caught in her flea collar at the level of her axilla, resulting in a laceration. The plan was to anaesthetize the cat to dislodge the flea collar, assess and manage the wound and conduct a thorough physical examination.

The cat weighed 3.6kg and was sedated with a combination of 0.3mg/kg methadone, 0.025mg/kg atropine and 0.08mg/kg acepromazine (0.6mL MAA) subcutaneously and induced with 5.5mg/kg (2mL) alfaxan intravenously. She was intubated with a 3.5mm endotracheal tube and maintained on inhalational isoflurane/oxygen anaesthetic.

The flea collar was cut away and with it, a strip of necrotic skin and some tissue sloughed off. The wound on the axillae was large, exudative and had a putrid odour. **(Editor's Note: this suggested the likelihood of an anaerobic infection.)** The wound was flushed with sterile saline and debrided, revealing the extent of the open wound. Some muscle and soft tissue were exposed but the wound did not extend deep enough to expose any major nerves or vessels. There was a significant amount of granulation tissue and the wound looked like it was healing. On manipulation of the right limb, there were no obvious fractures or dislocations that could be felt but the elbow was significantly stiff in extension and difficult to flex even under anaesthesia. The right carpus was in flexion but it could be extended easily. The cat recovered well from anaesthesia but seemed to be knuckling on her right carpus although further investigation was required to determine if it was due to proprioceptive deficit or a musculoskeletal problem. The right forelimb was monoparetic, there was no paw positioning reflex but a deep pain response was present. All other limbs were normal.

Problem List

- Large laceration wound on right axilla
- Monoparesis of right forelimb
  - Stiff extended right elbow
  - Flexed right carpus

Differential Diagnosis and Assessment

The large open wound on the right axilla was due to laceration from the flea collar when the limb got caught in it. However, this does not help to explain the stiffness in the right elbow and flexion of the right carpus. The first step to formulating and narrowing down the differential diagnoses would be to ascertain if lameness of the right forelimb was due to an orthopedic, muscular, neurological or a neuromuscular junction cause.

In this case, the main differential diagnoses considered for lameness or monoparesis were as follows:

- Temporary joint stiffness
- Brachial plexus avulsion
- Radial nerve injury
- Fractured or dislocated shoulder
- Other localised nerve, muscle, ligament or tendon damage
- Localised tetanus

Temporary joint stiffness of the elbow due to disuse was considered as the cat had her right forelimb caught in the flea collar for up to a week and was unable to move it. It is also possible that an inflammation of the tendons or musculature around the elbow joint could have resulted in some stiffness as well.

Brachial plexus avulsion was a concern but the wound did not seem extensive enough to have caused injury to the brachial plexus. That would usually cause a flaccid paralysis and loss of sensation of the affected limb instead of rigidity (Garosi 2012). Radial nerve injury was also considered but it typically presents with both the elbow and carpus locked in flexion (Garosi 2012). Although no obvious fractures or dislocations could be palpated, radiographs are required to rule out any orthopedic injuries.

Diagnosing localised tetanus in cats can be quite the challenge if one has not seen a case or heard of it before as it is a relatively uncommon disease with unusual presenting signs. However, this syndrome has hallmark presenting signs, making them almost pathognomonic so we hope that this short report would enable other veterinarians to easily recognise these signs and make a quicker diagnosis in future cases. As we were unfamiliar with this syndrome and the presenting signs were not that pronounced initially, we considered and tried to rule out the above differential diagnoses first. A conclusive diagnosis was not made by this point of time and it was decided to treat the cat conservatively and reassess in a few days.

Initial Conservative Treatment: 8 May 2013

The cat was treated with 11.1mg/kg (0.5mL) Convenia®/Cefovecin injection, a broad-spectrum long-acting antibiotic, and 0.42mg/kg (0.3mL) Metacam®/Meloxicam, a non-steroidal anti-inflammatory, subcutaneously. She was then sent home with 0.125mg/kg (0.3mL) oral Metacam®/Meloxicam and strict cage rest as part of conservative treatment and was due for a revisit in 2 to 3 days time for repeat wound cleaning and reassessment under sedation.

Review and Re-assessment: 11 May 2013

The cat was represented for reassessment and wound cleaning under sedation. The cat had been hiding a lot at home, but had been eating, drinking, urinating and defecating normally. The cat was quiet, alert and responsive but the extensor rigidity in her right forelimb had gotten worse and was non-weight bearing on the affected limb.

She was sedated with 0.19mL Domitor®/Medetomidine and 0.15mL methadone combined intramuscularly. Radiographs were taken of the elbow joint under sedation to rule out any skeletal problems like fractures, dislocations or osteoarthritis (Fig 1.1-1.2). The radiographs were normal on both lateral and cranio-caudal views. Fig. 1.1 also shows the extent of the soft tissue wound in the area of the axilla.

There was some discharge around the axilla wound edges, which was cleaned with chlorhexidine solution. Otherwise, the wound seemed to be granulating well. The right forelimb was now worse than before, with the elbow locked in full extension and the carpus remaining in flexion. There was limited movement in the shoulder and severe extensor rigidity in the elbow, which could not be manipulated or flexed at all (Fig. 1.3).

Interpretation and Diagnosis: Localised Tetanus

After worsening of the extensor rigidity and ruling out other orthopedic involvement, the cat's current presentation looked like a classic case of localised tetanus. A cat that develops extreme localised forelimb rigidity, elbow extension and carpal flexion after a traumatic injury (Fig. 1.3) is a poster child for localised tetanus, although it can occur in the hindlimbs or tail as well. Thus, the diagnosis of localised tetanus was made in this case based on the strongly suggestive history and presenting signs.

Tetanus is caused by a neurotoxin from the anaerobic spore-forming bacteria, *Clostridium tetani*. It occurs due to localisation of tetanus spores from the environment into a wound and under anaerobic conditions often created by necrotic tissue, converts to a toxin-producing form (Risio & Gelati 2003). The toxin, tetanospasmin, binds to presynaptic site of inhibitory neurons, blocks the release of inhibitory neurotransmitters and results in constant activation of motor units, appearing as localised or generalised muscle spasms (Risio & Gelati 2003; Langner *et al.* 2011). Cats have an innate resistance to this toxin, related to the difficulty in tetanospasmin penetrating and binding to nervous tissue so it does not occur commonly and when it does, its effects

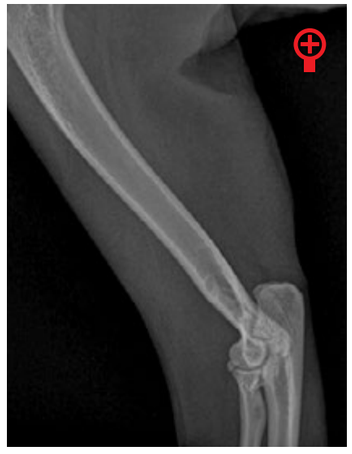

Figure. 1.1 Lateral radiographic view of the right elbow

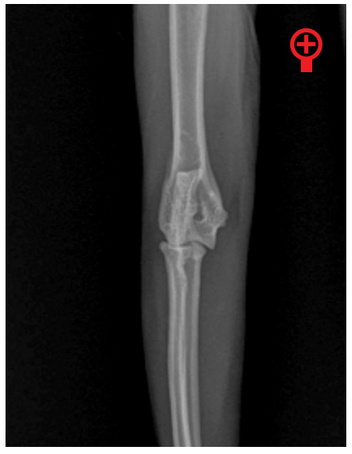

Fig. 1.2 Cranio-caudal radiographic view of the right elbow

Fig. 1.3 Hallmarks of Localised Tetanus: Forelimb rigidity, elbow extension and carpal flexion

are localised (Risio & Gelati 2003; Langner *et al.* 2011). Binding of the toxin to presynaptic sites is irreversible and recovery is slow as it depends on sprouting of new axonal terminals (Risio & Gelati 2003).

Potential Diagnostic Tests

To obtain a definitive diagnosis, culture and isolation of *Clostridium tetani* can be done from the site of infection but this is often challenging as anaerobic bacteria can be difficult to culture and a negative result does not rule out this diagnosis (Baral *et al.* 2002). Electromyography (EMG) can be helpful in investigating peripheral nerve injury or neurological involvement in cases of occult lameness where an orthopedic cause cannot be identified and can also be helpful in diagnosing tetanus (Baral *et al.* 2002; Garosi 2012). An EMG would demonstrate a characteristic persistent motor unit activity in cases of tetanus and serum tetanus antibody titres may also be useful but these options are not widely available (Baral *et al.* 2002).

Actual Treatment Plan

As *C. tetani* is an anaerobic bacteria, a suitable antibiotic must have a good anaerobic spectrum of activity. Metronidazole is bactericidal against most anaerobes including *C. tetani* and can attain effective therapeutic concentrations even in anaerobic tissues (Greene 1998). Metronidazole has also been shown to have superior effects compared to penicillin G and tetracycline in clinical and experimental tetanus cases (Baral *et al.* 2002). Metronidazole is often used with a broad spectrum antibiotic (eg. amoxycillin clavulanate) to improve anaerobic spectrum and provide additional cover for any other bacteria present.

14mg/kg (50mg) Metronidazole tablets and 14mg/kg (50mg) Amoxycillin-Clavulanate tablets were prescribed twice daily for 2 weeks. The owners were also instructed to continue with wound management at home, cleaning the wound with chlorhexidine solution and keeping it dry. The cat was to continue with 0.125mg/kg (0.3mL) oral Metacam®/meloxicam for pain relief and anti-inflammatory effects for 2 more weeks before coming back for a recheck and reassessment.

Potential Treatment Options

Other potential treatment options include tetanus antitoxin and muscle relaxants such as diazepam or midazolam. Tetanus antitoxin only works to neutralise any circulating toxins, it cannot dislodge the toxoid that has already been bound and thus it is unlikely to be useful if signs are localised and not progressing (Baral *et al.* 2002). Administering the antitoxin does have its risks and may trigger an anaphylactic reaction (Risio & Gelati 2003). Benzodiazepines may help reduce discomfort from the muscle rigidity throughout the long recovery period but their effects have been inconsistent and variable in cats with localised tetanus (Baral *et al.* 2002).

Outcome

The cat's wound granulated and healed completely within 3 weeks. Her owners continued to keep her under strict confinement and monitored her progress. She completed her 2 week course of antibiotics and was not given any more as she was becoming a challenge to medicate orally at home. Her limb remained tetanic until 7 weeks post-injury, when her owners noticed that it was starting to free up. The cat continued to improve rapidly over the next 2 weeks and eventually regained full function of her affected limb approximately 9 -10 weeks post-injury.

Conclusion

Localised tetanus in cats is a relatively uncommon disease with peculiar presenting signs, which makes diagnosis difficult. The purpose of this case report is to help readers recognise this syndrome, enable early diagnosis and administration of prompt treatment in similar cases seen in practice in the future. This is important as localised tetanus can actually progress to generalised tetanus if left untreated (Baral *et al.* 2002). With appropriate treatment, the prognosis for cats with this disease is very good although it may take up 2 to 4 months for complete resolution (Baral *et al.* 2002; Risio & Gelati 2003).

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VENLAFAXINE (EFFEXOR) INGESTED BY A CAT: A FEEL-GOOD STORY

C&T NO. 5383

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Venlafaxine is a popular human anti-depressant medication marketed as Effexor. It is also indicated for treatment of generalised anxiety disorder, social anxiety disorder and panic disorder in humans. I had no idea it was toxic to cats (or that cats would seek these pills out) until we had a case recently. This case is very mild, but I thought it worth writing about as there really isn't much literature on this subject and it is possible that Australian vets are seeing these cases or will come across them in the near future.

A few years ago venlafaxine made it to number 3 on the ASPCA's top 10 toxins of cats (permethrin insecticides sit pretty at number 1, but other insecticides, glo-sticks, lilies, liquid potpourri, NSAIDs, paracetamol, anticoagulant rodenticides and amphetamines follow).

In this case I had a Sunday morning phone call from an owner whose cat, 'Ellie', had eaten her Effexor tablet. The owner had set out the tablet with a fish oil capsule on a plate, left the room to make breakfast and returned to find the tablet missing and tooth marks in the fish oil capsule.

I had not heard of this agent before but a quick internet search revealed it is toxic to cats so we recommended bringing the cat down immediately. On admission the 2-yo FN DSH in excellent body condition (BCS 3/5, 5.0 kg) appeared normal albeit with bilateral mydriasis. On physical examination the cat had a very quiet demeanour, HR 220, pink mucous membranes with normal capillary refill (<1 second), T 38.4°C. There were very mild muscle fasciculations in the flanks and over the hindlimbs. The cat was not on other medications and had enjoyed good health. The mydriasis, muscle fasciculations and tachycardia were all thought to be due to the venlafaxine (although the stress of being caught and transported to the vet may have played a role in these signs).

A call to the NSW Poisons Information Centre found that in humans, venlafaxine overdose is associated with delayed seizures (up to 16 hours post dosage) and cardiorespiratory depression.

Bloods were drawn for a baseline biochemistry panel and electrolytes, all of which were within normal ranges. An IV catheter was placed and Hartmann's administered at 10mL/kg/hr.

An attempt was made to induce vomiting by giving xylazine (at this stage, probably 30 minutes following ingestion) IM to no avail (why does it never happen when you WANT it to?). In fact, this produced sedation so a reversal agent atipamezole was administered. The muscle fasciculations disappeared at this point.

When the cat was sitting up we administered activated charcoal 1g/kg PO to mop up any drug left in the stomach.

A search on Web of Science revealed no peer reviewed case reports or case series on this toxin in cats. A search on VIN revealed some discussion threads and links to general articles available online, although no reports of any fatalities associated with this drug in cats that I could locate.

I learned that venlafaxine is a bicyclic antidepressant which causes a huge increase in CNS serotonin and noradrenaline levels and a small increase in dopamine levels. In the US it is available in tablets and capsules at doses of 25, 37.5, 50, 75, 100 and 150mg.

It is available in 2 formulations: immediate and slow release. Onset of signs is usually within 8 hours of ingestion but the slow or extended release formulation may be associated with onset of clinical signs up to 72 hours following ingestion.

It is well absorbed orally and highly protein bound. All sources I could locate online commented on how appealing the capsules seem to be to cats though didn't explain why.

Activated charcoal is effective, but dosing should be repeated at 4-6 hours if the sustained release formulation was ingested, as it was in this case.

According to US Toxicologist and VIN consultant Tina Wismer, mild depression can be seen with ingestion of as little as 1mg/kg PO, with other signs including mydriasis, tachypnoea, vomiting, tachycardia, ataxia, agitation, tremors and seizures being potentially observed.

The recommended treatment is similar to treatment for overdose of selective serotonin reuptake inhibitors (SSRIs), notably:

- Emesis or gastric lavage in asymptomatic animals
- Blood pressure monitoring and IV fluid administration (fluids don't seem to increase excretion but they support BP and maintain renal function)
- Acepromazine for agitation
- Methocarbamol for muscle fasciculations or tremors

Back to TOC page

- Midazolam or barbiturates or Kepax® for seizures
- Cyproheptadine can be used to treat agitation which may be a sign of serotonin syndrome, dose is 2-4mg PO per cat; while there is no evidence, multiple sources recommend crushing the tablet in saline and administering per rectum if PO administration is not possible due to emesis or seizuring)

After I posted about the case on VIN, Dr Wismer advised that if the cat is simply sedated and ataxic, IV fluids are the most appropriate treatment. Gastric lavage is not needed. Dr Wismer was not aware of case fatalities in cats exposed to this dose.

The cat in this case maintained normal blood pressure on IVF and improved overnight with mydriasis resolving and no further fasciculations.

A follow up phone call 3 days after discharge confirmed that the patient was bright and well with no symptoms of toxicity.

Useful references

Carlson D and Giffin JM (2008) Common Poisonings in Cats, from *Cat Owner's Home Veterinary Handbook*, Wiley. Available online at *www.medicinenet.com/pets/cat-health/common_poisonings_in_cats-page2.htm*

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Pfizer Canada Inc (2012) Product monograph EFFEXOR® XR Capsules (Venlafaxine hydrochloride) Extended Release Capsules (37.5, 75, 150mg), available online at *www.pfizer.ca/en/our_products/products/monograph/258*

Wismer T (2006) Antidepressant drug overdoses. *Veterinary Technician* 278-281, available online at *www.aspcapro.org/mydocuments/d-wismer-tox_brief-may_vt_06.pdf*

INVITED COMMENTARY COURTESY OF:

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While it is rare for cats to willingly ingest medications, cats seem to readily eat venlafaxine. It is not uncommon for the ASPCA Animal Poison Control Center to receive phone calls about cats that have eaten several capsules. Cats can become symptomatic at low doses but usually respond very well to therapy. Length of treatment will vary depending on when the animal presents (can you decontaminate?) and the formulation of the medication (immediate vs extended release). Treatment time can be 24-72 hours. Venlafaxine binds well to activated charcoal and charcoal administration can stop any signs from occurring. Due to the costs involved with a long treatment time, there has been some interest in using intravenous lipid therapy to decrease treatment time. Venlafaxine is lipid soluble and lipids have been used for treatment of overdoses in human medicine. As an aside, venlafaxine will give a false positive for PCP on many over-the-counter urine drug screen tests.

Figure 1. The pill packet brought in by the owner.

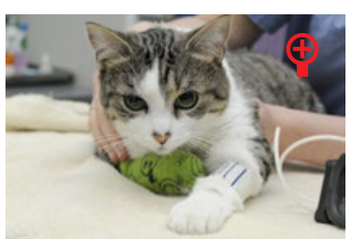

Figure 2. The patient, Ellie, with mydriasis.

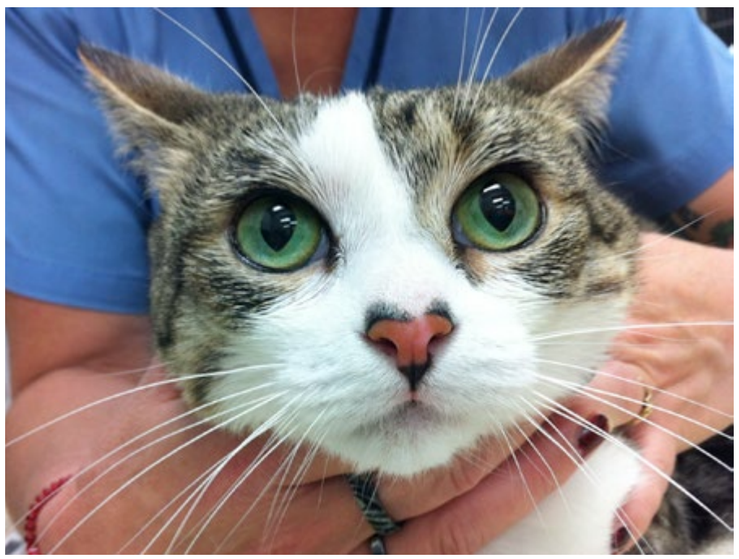

Figure 3. Ellie 24 hours later.

WINNER!

POSSIBLE CRANIOSYNOSTOSIS IN PERSIAN CATS

C&T NO. 5384

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Two unrelated Persian kittens were presented in March 24th and April 30th, 2013 for routine vaccinations. Both kittens were owned by 2 different breeders in Victoria who had never shared breeding lines.

The kittens presented with dorsal cranial ridging affecting the frontal bones as a symmetrical deformation. The clinical examinations of both kittens were otherwise normal, with no visible cranial nerve deficits, or cognitive or behavioural dysfunction.

Kitten 1 had been raised on a mixture of Whiskas dry kitten food and home-made meat recipe, and the other exclusively on Royal Canin Kitten dry food. No evidence existed of *in utero* exposure to any drugs during the pregnancies. Radiographic and CT analysis[1] of one kitten revealed premature lateral suture closure with dorsal deviation of the skull, similar clinically to craniosynostosis in humans.

In humans, there are a variety of syndromes which underly the pathogenesis of craniosynostosis such as Sathre-Chotzen syndrome, Apert Syndrome or Pfeiffer Syndrome, and all human cases have a genetic basis (transcription factor TWIST and fibroblast growth factor receptor genes FGFR1, 2, 3) underlying the clinical presentation which includes craniofacial defects, open fontanelles, Chiari malformations, visual impairments and cerebral hypertension[2]. Human craniosynostosis can also arise as a congenital defect due to *in utero* exposure to mutagens such as cyclophosphamide, nitrosatable drugs or processed meats[3]. Surgical intervention via craniostomy is usually curative of the cranial defect in human patients.

No feline specific DNA tests are available to ascertain the veracity of a claim of craniosynostosis, but the syndrome in cats appears remarkably similar to the human syndrome, although other malformations associated with human syndromes appear absent.

The possibility of nutritional secondary hyperparathyroidism causing this skeletal malformation cannot be excluded, although no other radiographic evidence of bone thinning, spontaneous long bone fractures or lameness have been observed in these kittens or from related kittens in each litter.

[1]CT analysis performed by Dr Charles Kuntz, Southpaws Animal Hospital, Moorrabbin, Australia

[2]Chun K et al (2003) Screening of patients with Craniosynostosis: Molecular Strategy. *American Journal of Medical Genetics* 120A:470-473

[3]Olshan AF & Faustman EM (1989) Nitrosatable drug exposure during pregnancy and adverse pregnancy outcome. *Int J Epidemiol* 18(4):891-899

Figure 1. Suspect craniosynostosis in a 6-week-old Persian, with anterior deviation of the cranium.

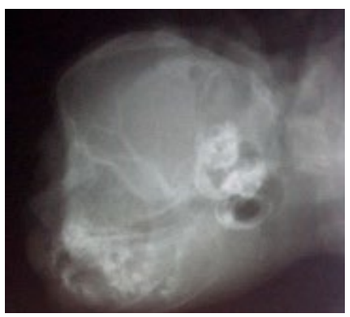

Figure 2. Radiograph of same kitten, showing dorsal ridging of the squama frontalis bones.

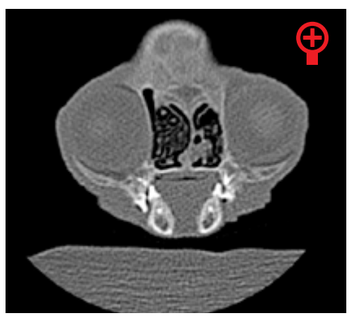

Figure 3. CT scan of same kitten showing prominent dorsal ridging of anterior cranium.

Back to TOC page

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C&T NO. 5385

QUESTION

Please comment on the use of Emetics and Gastric Lavage in Dogs that eat a whole 500gram packet of Defender (Metaldehyde 15g/kg)

Keypoints

- Reported LD50 of Metaldehyde for dogs ranges from 200-600mg/kg, hence a 500gram packet is potentially lethal for dogs weighing 12.5 – 37.5kg body weight
- Metaldehyde is a gastric irritant and can produce severe vomiting with a depressed mental status accompanied by recurrent seizures
- Metaldehyde's poor water solubility may limit its rate of absorption; however, once absorbed it is quickly metabolised, with almost certain involvement of the cytochrome P450 system. It is only moderately fat soluble (log P value 1.17) but crosses the blood-brain-barrier readily. Less than 8% is excreted unmetabolised in the urine and faeces (mice) and <1% is urinary excreted (dogs)
- Human studies have revealed peak serum levels of Metaldehyde 35 hours after ingestion and it has been found in the serum and urine for 3-4 days post-ingestion. Elimination half-life is reportedly 27 hours
- Metaldehyde is absorbed across all the gastrointestinal (GIT) surfaces; after ingestion it is partially hydrolysed in the stomach to acetylaldehyde (which presumably is rapidly hydrolysed to CO_2 and respiratory eliminated) while the residual Metaldehyde is well absorbed from the intestines; it is excreted in the urine and bile, being trapped in the enterohepatic cycle

Emesis

Apart from the described (Perspective 101, – Rhian Cope & Rosalind Dalefield) potential complications of inducing emesis, contra-indications to getting the patient to vomit with Metaldehyde poisoning include its inherent gastric irritability and the potential for aspiration in patients who may develop a depressed level of consciousness or seizures.

Perhaps an argument could be made to induce emesis in a peracute ingestion (<30-60 minutes) of a large volume of Metaldehyde in a clinically normal dog under controlled conditions (veterinary clinic) where rapid airway access and control can be established if needed.

Gastric Lavage

Despite the eloquently detailed shortcomings and potential complications of gastric lavage detailed in Perspective 101, the above massive ingestion of a highly toxic substance (say 7.5 grams) as Metaldehyde which is absorbed over all the GIT, and which is enterohepatically recycled warrants strong consideration for gastric lavage and at least single dose activated charcoal treatment (SDAC). In fact, this is a situation where I feel careful enterogastric lavage (lavage of the whole GIT) is indicated, especially as these patients are often presented with clinical signs severe enough to necessitate anaesthesia and endotracheal intubation anyway. Multiple dose activated charcoal (MDAC) if the patient remains adequately airway protected has a good chance of enhancing elimination of Metaldehyde, in my view, due to its long half-life and its enterohepatic recycling.

I like Dr Ava Firth's comments in VECC 2 (1): 31-36, 1992 when reviewing a study of 56 cases of Metaldehyde poisoning – *'... aggressive removal of metaldehyde results in a high survival rate and significant reduction in the duration of treatment...'*.

Further comment from Terry King on Perspective 101 (Issue 273, Dec 2013)

A Toxicologist's Perspective 101 by Drs Rhian Cope & Rosalind Dalefield is the most comprehensive and logical review and commentary I've read on SDAC, MDAC, Catharsis & Enemas, Gastric Lavage, Emesis, and WBI. As with most of the *Control & Therapy Series*, I enjoyed reading it immensely, albeit squirming often at the thought of how wrong I've been in my treatment of many poisonings over the years. I applaud researchers and scientists working towards providing us with evidence-based medical facts, and am sorry that I won't be around long enough to see all these questions answered. The authors of Perspective 101 will have to forgive us practitioners for being slow to get up-to-date with the science (P. 60 'The reaction from the NZ veterinary profession') – we are still trying to get our heads around why a healthy dog starved for 12 hours for an elective surgical procedure can vomit up a full load of gastric contents when the evidence tells us that the canine stomach empties within 2-4 hours!

eBOOK

Perspective 101
A Toxicologist's Perspective
Rhian B Cope & Rosalind Dalefield

REPLY TO INVITED COMMENT ON C&T NO. 5332 CANINE BEHAVIOUR – HAVE WE GOT IT RIGHT?

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As veterinary surgeons we are scientists and are trained to view situations logically and unemotionally. I feel Kersti's group of Canine Veterinary Behaviouralists KGCVB (and I have discovered there are two camps) fail to do this.

We accept there are 3 or 4 ways to operate on a ruptured cranial cruciate yet we insist there is only 1 way to train a dog – our way. The insistence that we cannot even raise our voice or say no to our pets is embarrassing to our profession. I understand some owners are unable to be assertive and are prone to anxiety themselves. Surely the sensible route would be to work out a training routine based on the personality of the owner and the personality of the dog. Anxiety disorders are closely linked to the owner's behaviour, and are only going to become more common with this new order.

PERSPECTIVE NO. 103

CARDIAC TROPONINS: WHAT ARE THEY AND SHOULD WE BE USING THEM IN VETERINARY MEDICINE?

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Cardiac troponins are biomarkers. Biomarkers are naturally occurring molecules, genes or characteristics by which a process, disease etc. can be diagnosed and/or monitored. Cardiac troponins consist of three proteins known as Tn-C, Tn-I and Tn-T. They form a complex that interacts with tropomyosin in the contractile apparatus of cardiac muscle and are released after myocardial damage. In human medicine, troponins are used as markers in patients suspected of having a myocardial infarction due to coronary artery thrombosis, the most commonly occurring human cardiac disease. Troponins are also increased in small animals with myocardial injury so troponins are potentially useful in the diagnosis of cardiac disease. Troponin-I can be used in conjunction with ECG after trauma to help identify animals with myocardial contusions that are at risk of arrhythmias.

Cardiac troponins are sensitive and specific indicators of myocardial injury; however, they do not tell us anything about the mechanism of that injury.[1] In humans, elevated troponin levels are seen in a number of non-cardiac diseases including chronic renal failure (due to decreased clearance), cerebrovascular accidents (myocyte injury secondary to massive catecholamine release either locally in the myocardium or systemically), pulmonary embolism (cardiac shock?), chronic obstructive pulmonary disease (pulmonary hypertension, hypoxia, increased right ventricular afterload) and acute critical illness (cytokines). Strenuous exercise and direct myocardial trauma will also increase troponin levels in the absence of cardiac disease.

Cardiac biomarkers other than troponins are also being investigated in small animals. ProBNP is the precursor of the Brain-type natriuretic peptide (BNP), a natriuretic hormone released in response to neuroendocrine activation, hypoxia and stretch of heart muscle. The function of BNP is to balance the actions of the renin-angiotensin-aldosterone system (RAAS) promoting natriuresis and vasodilation. When proBNP is released, it is cleaved into an active BNP portion and inactive NT-proBNP portion. BNP has a short half-life in circulation, while the NT-proBNP fragment is stable and therefore easier to assay.

N-terminal pro-atrial natriuretic peptide (NT-proANP) is the precursor of ANP. Higher atrial pressures stimulate the production and release of ANP. Its role is similar to that of BNP viz. to promote natriuresis and diuresis. It is used in humans to predict disease severity and mortality, to monitor response to treatment and identify patients with asymptomatic cardiac disease.

Potential utility of cardiac biomarkers in veterinary medicine:

1. Differentiating cardiac from non-cardiac causes of respiratory disease
2. Detection of occult cardiac disease
3. Staging of cardiac disease
4. Assessing response to therapy for cardiac disease
5. Prognosis in cardiac disease

IDEXX laboratories offer testing for levels of NTproBNP. The IDEXX website recommends the Cardiopet® proBNP Test for all dogs presenting with murmurs and additional clinical signs that may or may not be attributable to cardiac disease, and to screen for occult hypertrophic cardiomyopathy in cats with or without clinical signs.

Vetnostics Laboratory offers Tn-I testing. No diagnostic guidelines are available with this test at the time of writing.

Back to TOC page

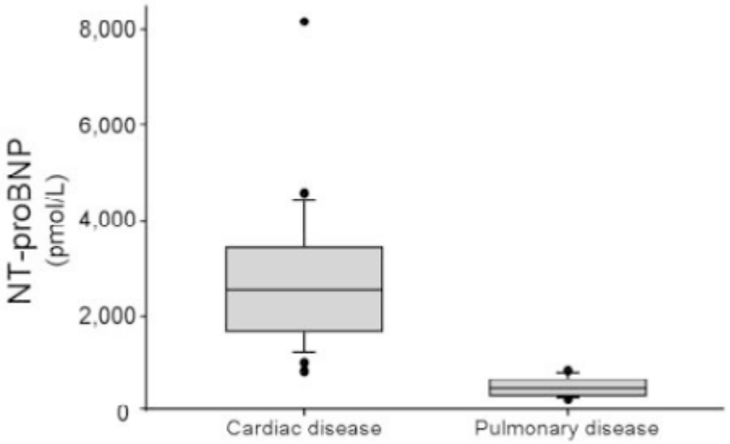

Figure 1: Box Plots of serum or plasma NT-proBNP concentrations in dogs with cardiac respiratory disease or pulmonary respiratory disease. From [3].

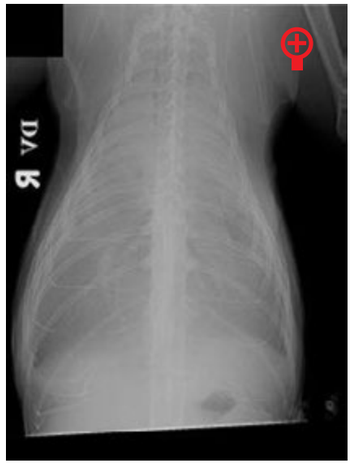

Figure 2. Radiograph is of a 10-year-old cat with a pleural effusion: differentials include cardiac disease as well as a plethora of other causes.

What is the evidence?

Most papers on this subject present their findings in terms of sensitivity and specificity. A highly sensitive test is one that picks up all possible positives, though may also pick up a few negatives on the way i.e. it has some false positives. With 100% sensitivity you can be sure that all animals with the condition being screened for will be picked up. A highly specific test will only pick up those animals that are truly positive. The down side is that some positive animals may not be detected. With 100% specificity, you can be sure that all positive animals definitely have the condition being screened for.

Another way results are presented, and one that is perhaps more intuitive, is to describe test cut-off values in terms of positive predictive values (PPV) or negative predictive values (NPV). If a test has a 95% PPV at a specified cut-off level, any animal over this level has a 95% chance of actually having the condition being screened for.

Will cardiac troponins help us differentiate cardiac from non-cardiac respiratory disease?

Animals with acute respiratory disease present frequently to small animal practitioners. While treatment basics are similar – decreasing stress and supplying supplementary oxygen, the underlying cause must be identified before definitive treatment can be provided. This is not always easy, especially when it comes to deciding whether the moderate mitral valve murmur you can hear is involved in the disease process or an incidental finding.

One paper showed that when a NT-proBNP assay with a cut-off value of 265 pmol/L was added to clinical exam of 10 **cats** with respiratory signs, the accuracy of diagnosis of primary respiratory disease or congestive heart failure increased from 69% to 87%.[2]

Another paper evaluated NT-proBNP levels in dogs with respiratory distress or a cough.[3] The 25 dogs found to have cardiac disease had significantly higher NT-proBNP levels than the 21 dogs with respiratory disease. Median levels were 2544 pmol/L, and 357 pmol respectively, (see Figure 1) and no overlap between the 2 groups was reported. Dogs with concurrent cardiac and respiratory disease were excluded from analysis.

In congestive heart failure, peripheral vascular resistance increases as a result of activation of the sympathetic nervous system and increased concentrations of angiotensin II, vasopressin and endothelin-1 (ET-1). In a study comparing Tn-I, NT-proANP, BNP and ET-1 concentrations in 48 dogs,[4] dogs with respiratory disease of cardiac origin had significantly higher levels of NT-proANP, BNP and ET-1 than dogs with non-cardiac respiratory disease. Tn-I was not significantly different between groups.

Cats with cardiac dyspnoea had higher Tn-I levels (median 1.59 ng/mL, range 0.2 – 30.24 ng/mL) than cats with non-cardiac dyspnoea (median 0.165 ng/mL, range 0.01 – 1.42 ng/mL).[5] While there was a lot of overlap between the cardiac and non-cardiac groups, very high levels of Tn-1 were supportive of cardiogenic respiratory disease. A cut-off of 0.2 ng/mL had a sensitivity of 100% but a specificity of only 58% for identifying CHF as the cause of dyspnoea.[6] Alternatively, a cut off of 1.43 ng/mL had a sensitivity of 58% but a specificity of 100%.

One of the limitations in using cardiac troponins to aid diagnosis in an emergency case is the delay in receiving results. A recent study evaluated Tn-I using the i-STAT cage side analyser to differentiate cats with cardiac and non-cardiac causes of dyspnoea. This study found that all normal control cats had Tn-I levels of 0.0 – 0.09 ng/mL. The findings in this study were similar to those in Herndon 2008: cats with cardiac dyspnoea had higher Tn-I levels (median 1.68 ng/mL, range 0.24 – 50.00 ng/mL) than cats with non-cardiac dyspnoea (median 0.16 ng/mL, range 0.02 – 0.66 ng/mL). There was no overlap between healthy cats and cats with cardiac dyspnoea, but 9 of 25 cats with cardiac dyspnoea had Tn-I concentrations in the same range as cats with non-cardiac dyspnoea.

Will cardiac troponins help us detect occult cardiac disease?

A possible alternative: detecting occult cardiac disease in cats and dog may allow earlier treatment, delaying the development of clinical signs and death in some patients. [7]

A 2004 study attempted to establish a reference intervals for Tn-I in normal dogs and those with cardiac disease.[8] Healthy dogs had a median Tn-I of 0.03ng/mL (range 0.01 - 0.15 ng/mL), which was significantly lower than dogs with previously diagnosed cardiomyopathy (median 14 ng/mL; range 0.03 – 1.88 ng/mL), mitral valve disease (median 11 ng/mL; range 0.01 – 9.53 ng/mL) and subaortic stenosis (median 0.08 ng/mL; range 0.01 – 0.94 ng/mL). Again, there is significant overlap in the groups meaning that Tn-I is not a stand-alone test for the diagnosis of cardiac disease although very high levels are suggestive of cardiac disease.

A study of 39 dogs and 14 cats found that Tn-I is elevated in dogs and cats with azotaemic renal failure and with other non-cardiac diseases.[9] Tn-1 is cleared from the body via renal excretion but increased levels were not correlated with and could not be corrected for the severity of azotaemia. *This study casts doubt on the utility of Tn-I to diagnose cardiac disease in patients with co-morbidities.*

Twenty cats with hypertrophic cardiomyopathy had higher Tn-I levels than 33 clinically healthy cats.[10] A cut-off value of > 0.157 ng/mL was established as abnormal in an otherwise healthy cat although 3 of the 20 cats with HCM had values below this level. Cats with CHF also had significantly higher Tn-I levels than those that had never had CHF or whose clinical signs were well controlled at the time of testing.

Will cardiac troponins help us stage cardiac disease?

The use of Tn-I to assess severity of disease and prognosis in 120 dogs with a heart murmur or an enlarged cardiac silhouette on thoracic radiography was investigated.[11] Dogs were divided into 3 groups based on initial Tn-I levels. Dogs in the group with normal Tn-I levels (< 0.15 ng/mL) had no or stable cardiac disease, were younger and had a significantly increased survival time. In the groups with elevated Tn-I levels, no significant difference between levels in dogs that died and those that survived was found so a single sample did not seem sufficient to provide prognostic information.

Biomarker	Species	Diagnostic Utility	Cut-off	Reference
Tn-I	Dog	Normal value	95% normal dogs < 0.11 ng/mL Cardiac disease > 0.11 ng/mL	Oyama
Tn-I	Cat	Normal value	< 0.10 ng/mL	Wells
Tn-I	Dog & Cat	Effects of azotaemia and systemic disease on Tn-I levels	70% above reference range ie > 0.18 ng/mL Dog, > 0.3 ng/mL Cat	Porciello
Tn-I	Dog	Prognosis	Significant decrease at 2 months after treatment improved survival	Porciello
Tn-I	Dog	Prognosis	< 0.15ng/mL increased survival	Fonfara
Tn-I	Dog	Prognosis: MVD	> 0.2 ng/mL shorter survival	Oyama
Hsc Tn-I	Dog	Prognosis	> 0.025ng/mL shorter survival	Hezzell
Tn-I	Cat	Normal vs HCM	> 0.157 ng/mL abnormal	Herndon 2002
Tn-I	Cat	Non-cardiac vs cardiac respiratory disease	> 0.2 ng/mL 100% sensitivity for detection of cardiac disease and > 1.43 ng/mL 100% specificity for detection of cardiac disease	Herndon 2008
Tn-I	Cat	Non-cardiac vs cardiac respiratory disease	> 0.24 ng/mL 100% sensitivity and > 0.66 ng/mL 100% specificity for detection of cardiac disease	Wells
Pro-BNP	Dog	Non-cardiac vs cardiac respiratory disease	< 900 pmol/L normal > 1800 pmol/L likely heart failure	IDEXX laboratory
Pro-BNP	Dog	Prognosis	> 738.5 pmol/L greatest chance of dying in one year	Moonarmart
BNP	Dog	Non-cardiac vs cardiac respiratory disease	> 17.4 pg/mL cardiac disease more likely	Prosek
Pro-BNP	Cat	Diagnosis of cardiomyopathy (CM) (with or with out clinical signs)	< 100 pmol/L CM unlikely 100 – 270 pmol/L early or occult CM possible > 270 pmol/L CM likely	IDEXX
Pro-BNP	Cat	Non-cardiac vs cardiac respiratory disease	> 265 pmol/L cardiac disease more likely	Singletary
NT-proANP	Dog	Non-cardiac vs cardiac respiratory disease	> 0.587 nmol/L cardiac disease more likely	Prosek
ET-1	Dog	Non-cardiac vs cardiac respiratory disease	> 0.487 fmol/mL cardiac disease more likely	Prosek

Back to TOC page

Will cardiac troponins help us assess response to therapy for cardiac disease?

Currently, there are limited ways to assess response to therapy other than the owner's assessment of quality of life. While this is certainly important, an objective assessment of improvement that allows us to give an accurate prognosis is needed. In the above study,[11] dogs with above normal Tn-I levels that decreased significantly within 2 months of initiating therapy had increased survival times compared to those whose levels did not decrease in response to treatment.

Will cardiac troponins help give us a prognosis in animals with cardiac disease?

Mitral valve disease is the most commonly diagnosed cardiac disease in dogs. It has a variable rate of progression and some dogs with a murmur never go on to develop heart failure. A method of differentiating dogs at risk of cardiac disease from those who were likely to remain asymptomatic would be beneficial to owners and veterinarians alike.

A study that looked at whether levels of NT-proBNP would predict mortality in dogs with mitral valve disease found that both NT-proBNP and left ventricular end-diastolic diameter are independent predictors of survival.[12] Dogs with NT-proBNP > 738.5 pmol/L had the greatest chance of dying of cardiac disease in the year following diagnosis, and for every 100 pmol/l increase in NT-proBNP the hazard of all causes of mortality increased 1.07 times.

In another paper, dogs with mitral valve disease and Tn-1 levels over 0.2 ng/mL had a shorter survival than dogs with Tn-I levels < 0.2ng/mL.[8]

In a third paper, levels of high-sensitivity cardiac troponin-I (hscTn-I) was found to be prognostic in 202 dogs with degenerative mitral valve disease.[13] This paper did not find that NT-proBNP was prognostic. Dogs with hscTn-I > 0.025ng/mL had shorter survival times. The rates of increase of NT-proBNP and hscTn-I over time were also associated with likelihood of dying of cardiac-related disease.

My conclusions

While cardiac biomarkers are ecxiting, non-invasive and promising, there are overlaps between the levels found in healthy animals vs those with cardiac disease, and in cardiac respiratory disease vs non-cardiac respiratory disease dogs and cats for each marker tested. In addition to this, animals with systemic illness may have elevations in troponins unrelated to cardiac disease.

The different reporting methods and various cut-off points used to achieve statistical significance in the above papers also make drawing clinical conclusions difficult.

So yes, troponins and other biomarkers might help to distinguish cardiac from non-cardiac respiratory disease, especially if the animal has a loud murmur. But in an emergency situation, clinical examination, traditional imaging modalities +/- response to treatment are still of greater utility.

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Back to TOC page