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PRINCIPAL INVESTIGATOR: Cynthia M. Otto, DVM, PhD

CONTRACTING ORGANIZATION: University of Pennsylvania
Philadelphia, PA 19104-6205

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14. ABSTRACT Working dogs are relied upon to protect our national security and respond to disasters. These dogs often are subject to adverse environmental conditions including high temperatures and humidity levels which can lead to dehydration. Dog handlers currently use water (W), subcutaneous fluids (SQ), and oral electrolyte solutions (OES) to prevent dehydration. Safety and efficacy of these hydration strategies have not been previously studied. The aim of this study was to compare the effects on hydration status and performance in Border Patrol dogs in their various working environments. We hypothesized that for all hydration parameters there would be no difference between the oral electrolyte solution (OES), water (W) and subcutaneous fluids (SQ) groups. Phase 1 found that in dogs conditioned to work in the hot humid environment screening vehicles at the Texas border, there was no detectable influence of hydration strategy on any parameter except fluid consumption, fractional Na excretion, and urine specific gravity. Phase II found that hydration strategy did not impact performance or physiology in dogs conditioned for work mantracking in the hot and arid environment of the El Paso, TX Canine Training Station. No adverse effects of any strategy were identified. No performance enhancement could be detected with any strategy; however, palatability of the oral electrolyte solution remained high and was associated with a higher handler satisfaction.					
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MAINTAINING CANINE HYDRATION IN HOT WORKING ENVIRONMENTS

Cynthia M. Otto, DVM, PhD
University of Pennsylvania School of Veterinary Medicine

W81XWH-13-1-0038

1. INTRODUCTION

Dehydration can reduce performance and put military working dogs (MWD) at risk of injury or illness. Environmental conditions of temperature and humidity extremes can adversely impact hydration. The type of work and duration of work can also influence the ability for a canine to maintain appropriate hydration. Various strategies have been attempted to minimize the impact of adverse working environments on hydration, but are untested. This project evaluated strategies used to maintain hydration in working dogs in order to determine their safety and efficacy. This study focuses on hot environments and evaluated the impact of humidity on hydration strategies. Military working dogs in theater may have additional work or environmental stresses that further complicate hydration; however, this study aimed to provide the first evidence to support field practices.

2. KEYWORDS

Hydration, Working Dog, Subcutaneous Fluids, Oral Electrolyte, Tracking, Search, Fatigue

3. OVERALL PROJECT SUMMARY,

3.1.1. Task #1. Arizona Pilot Study – changed to Texas due to logistics.

This phase of the study focused on developing and evaluating the testing techniques that were used in the final portion of the research conducted in the Texas desert during Year 2. In addition, the data generated is relevant for MWD working at checkpoint screening sites. The Texas Pilot Study used a cross-over design in which 7 Customs and Border Protection canines working their normal shifts, screening vehicles at the border, were assigned to one of the three hydration strategies. Dogs were randomly assigned to each of the three hydration strategies (oral water, oral electrolyte solution (OES), or subcutaneous fluid (SQ) preloading) on different days. A total of 7 dogs were evaluated, with a maximum of 3 dogs on a single day. In addition, to evaluate the logistics of working with tracking dogs which would more closely resemble the MWD, 4 tracking/air scent dogs were evaluated on one day, with one dog assigned to water, one dog assigned to subcutaneous fluids, and two dogs receiving oral electrolyte solution.

3.1.1.1. Sub-Task #1. On-site Data Collection.

To conduct analyses, the following metrics were collected on site:

- 1) Descriptive results: Three female and four male vehicle screening dogs participated.
- 2) Body weight: Weight in kilograms was obtained 3 times, the beginning, halfway through, and at the end of the 6-8 hour work cycle using a walk on electronic scale.
- 3) Fatigue: Rather than use a return of heart rate after a 6 min walk, due to the logistical constraints of that test, we evaluated total activity counts and behavioral data collected by video analysis during searches at the beginning and end of the day.

- 4) Serum electrolytes, chemistry, hematology and lactate: Obtained at 3 times, the beginning, halfway through, and at the end of the 6-8 hour work cycle using a point of care analysis (ISTAT and lactate meter).
- 5) Rectal temperature: Obtained at 3 times, the beginning, halfway through, and at the end of the 6-8 hour work cycle. Rather than a digital rectal temperature, we utilized core temperature with ingested sensors.
- 6) Urine specific gravity and microalbuminuria: Free catch urine samples were obtained at 3 times, the beginning, halfway through, and at the end of the 6-8 hour work cycle and analyzed using a refractometer and ERD dipsticks. In addition we measured urine sodium excretion.
- 7) Detection performance: A standardized scent problem was set up. The time from initiation of search from a standardized point to the time of indication was recorded and the activity counts were obtained.

3.1.1.2. Sub-Task #2. Off-site Data Analyses.

Off-site analyses of the data collected during the Pilot Study include:

- 1) Serum cytokines/biomarkers: Samples stored for future analysis. These samples have been collected and are stored at -80 in Dr. Otto's laboratory. The failure to document any evidence of heat stress or other physiologic alterations made us consider that the analysis of cytokines would be low yield. The samples are stored in case future biomarkers are identified that would be interest.
- 2) Total body water: Measurement of deuterium in plasma was taken at time 0, midday, and end of work. The results from this analysis proved to be inconsistent and unpredictable. These results have led to the decision to remove this technique from future studies.
- 3) Activity counts: Activity counts were obtained from the activity monitors placed on the collars of the dogs during work. These data were downloaded and analyzed to provide a quantitative assessment of total activity during the work period. All mixed models included the activity normalized to the duration of work.

3.1.1.3. Sub-Task #3. Data Analysis and Manuscript Generation.

The results of data collection Year 1 include:

- N = 7 dogs,
- 3 female, 4 male
- Median work time - 6 hours (IQR 5,6)
- Median Temperature - 84.8°F (range 74.0-99.9)
- Median Humidity - 70% (range 39-100)
- Median Wind Speed 5.6 mph (range 0-18)

Statistical Analysis

Mixed-effects linear models were fit using the lmer function in the lme4 package in the R statistical software package (Pinheiro 2013). This function fits mixed models to data with crossed factors and is robust to deviations from the normal distribution. For the full model, fixed factors included hydration strategy, sex, and breed and individual ID was a random factor. Covariates included activity count, dog's weight, age in months, change in pulse (maximum – minimum), liquid intake (ml/kg/h), change in urine specific gravity (morning - afternoon), ambient temperature (°F), and humidity. Absolute values for parameters at the completion of work were also evaluated.

The drop1 function was used to assess the significance of each fixed factor and covariate in contributing to the fit of the model. Fixed factors and covariates with $p < 0.05$ were included in a refined model. If any of these factors lost significance when drop1 was used with the refined model, a third model was fit. The reported p-values for factors were obtained using the ANOVA function in the 'car' package. The pairs function of the lsmeans package in R was used to obtain confidence intervals for hydration strategies when they contributed significantly to the fit of the model. Factors with significance > 0.05 when dropped from the full model were not included in subsequent refined models. Refined models were fit until all factors were significant at $P < 0.05$.

The explanatory factors tested in the full model were:

- Hydration strategy
- Average activity count
- Sex
- Breed
- Body weight
- Liquid intake (ml/kg/hr)
- Urine specific gravity
- Ambient temperature
- Humidity

Descriptive results: Three females and four males participated. Two females were spayed Belgian Malinois and one female was a spayed German Shepherd Dog. Of the males, two were neutered Belgian Malinois (one short coated, one long coated), and the intact males were a Belgian Malinois and a German Shepherd Dog.

- Mean age 5.5 +/- 1.9 yrs
- Mean weight 30.5 Kg +/- 4.2

Data

- 1) Average fluid consumption: For the water group was 7.0 ml/kg/hr, for the SQ group was 5.6 ml/kg/hr, and for the OES was 15.6 ml/kg/hr. Fluid consumption was significantly higher with OES.
- 2) Body weight: There was no significant effect of hydration strategy or time on body weight.
- 3) Fatigue: There was no effect of hydration strategy on activity counts/hour. The video data has been compiled and likewise there is no effect of hydration strategy on any of the behaviors recorded.
- 4) Serum electrolytes, chemistry, hematology and lactate: Hydration method had a statistically significant impact on end of work ionized calcium ($p=0.005$) and total CO₂ ($p=0.005$), but had no significant impact on lactate, sodium, potassium, chloride, glucose, creatinine, blood urea nitrogen, hematocrit, packed cell volume, total protein, hemoglobin, and anion gap. Subcutaneous fluids resulted in a higher iCa than OES and total CO₂ was significantly lower in water compared to OES. When comparing the difference in parameters from baseline to end of work, glucose was significantly lower in the OES group ($p=0.04$) and creatinine was significantly higher. None of the values were outside of the normal reference range (post exercise glucose for OES ranged from 74 mg/dl to 105 mg/dl; creatinine ranged from 0.8 to 1.1 mg/dl). In the model for change in glucose, age was also a significant variable ($p=0.04$); whereas breed ($p=0.002$), sex ($p=0.002$), fluid intake ($p=0.007$), and ambient temperature ($p=0.01$) were significant in the model for change in creatinine.

- 5) Rectal temperature: There was no effect of hydration strategy on peak or minimum temperature. The mean temperature recorded was 101.9°F. The maximum temperature recorded was 104.8°F. None of the measured variables were able to predict peak body temperature.
- 6) Urine specific gravity and microalbuminuria: There was no detectable microalbuminuria. Based on ANOVA, fractional sodium excretion was higher in the oral electrolyte group; however, this finding did not hold up in the mixed effects model.
- 7) Detection performance: Based on logistics and handler influence, time of search was not a reliable measure of detection performance. Behavior during search was coded (see fatigue).

Amendments made following Year 1 for Year 2

The data analyzed from Year 1 drove the inclusion of the following amendments to ensure the most robust data set at the completion of this project:

A1 – The venue for Year 2 has been changed to evaluate tracking dogs at the main training facility for the Border Patrol Canines in El Paso, TX. The dogs in this particular phase of training and location will more closely function like the military working dogs.

A2 – The addition of a new protocol, “flavored water”, was added to more specifically define if noted differences are related to simply increased consumption or the electrolyte components of the oral electrolyte solution.

A3 – The number of days per dog has been increased from 3 to 4 to accommodate the inclusion of the new protocol “flavored water”.

A4 – Reduction in frequency in offering water to evaluate if the strategies can reduce the burden on the soldier without incurring risk to the dog. Because these dogs were training and not performing essential duties, we were able to stop work if the dog shows signs of dehydration (e.g., excessive panting, persistent tachycardia, decreased willingness to search).

3.1.2 Task #2 Texas Final Study

This phase of the study evaluated the three hydration strategies from Year 1. Changes included the addition of a fourth (oral electrolyte solution (OES) flavor enhancer only referred to as the “flavored water”) and reformulation of the OES decreasing the Na content by 25% and increasing the K by 25%. This phase also utilized the CBP BOSTAR mantracking dogs instead of the checkpoint dogs from Year 1. The discipline of dog was changed as the hydration challenges in tracking work were greater (i.e., longer exposure, no shade, greater activity, higher working body temperatures) providing more opportunity to evaluate the hydration strategies in challenged dogs. Tracking was also more similar in the challenges faced by the special operations forces (SOF) canine. This phase also used a cross-over design in which 7 Customs and Border Protection canines participating in a tracking class at the El Paso, TX Canine Training Station were assigned to one of four hydration strategies (oral water, oral electrolyte solution (OES), subcutaneous fluid (SQ) preloading, or oral electrolyte solution flavor enhancer only (FLAV) on different days. All 7 dogs were evaluated on each day. Dogs each performed a 1 mile track in the desert. Tracks were laid individually for each dog but ran parallel to each other to control the degree of difficulty across dogs.

3.1.2.1 Sub-Task #1: Onsite Data Collection

To conduct analyses, the following metrics were collected onsite:

- 1) Descriptive results: Three female and four male BOSTAR tracking dogs participated.
- 2) Body weight: Weight in kilograms was obtained 3 times, at the beginning of the day, following their first track, and following their second track using a walk on electric scale.

- 3) Fatigue: We collected data on total activity counts during tracks. We had handlers report the number of breaks taken during the track and a subjective assessment of the dog's performance.
- 4) Serum electrolytes, chemistry, hematology and lactate: Obtained at 3 times, at the beginning of the day, following their first track, and following their second track using a point of care analysis (ISTAT and lactate meter).
- 5) Core body temperature: Obtained at 3 times, at the beginning of the day, following their first track, and following their second track. Rather than a digital rectal temperature, we utilized core temperature with ingested sensors. Temperatures were collected continuously during the track by securing the receiver to the dog's tracking harness and sporadically (based on availability of receivers) during the post track period.
- 6) Urine specific gravity: Free catch urine samples were obtained at 3 times, prior to the first track, after the first track, and at the end of the second track. Urine was analyzed using a refractometer on site and stored for further analysis. We elected to omit the microalbumin assays due to lack of positive result in Year 1.

3.1.2.2 Sub-Task #2: Offsite Data Collection

Offsite analyses of the data collected included:

- 1) Serum cytokines/biomarkers: We included the biomarker of muscle injury, creatine kinase. The samples have been collected and are stored at -80°C but the lack of difference in any of the parameters based on preliminary analysis has resulted in reconsidering the value of additional assays. We will consider focused markers after the data analysis for the current measures is finalized.
- 2) Total body water: Based on our results in the first year, we found the variability in this assay was too great to justify the cost; therefore, this analysis was not included in Year 2.
- 3) Fractional urine sodium excretion: Calculated based on plasma and urine Na and creatinine.

3.1.2.3 Sub-Task #3: Data analysis and manuscript generation

The results of data collection Year 2 include:

- N = 7 dogs,
- 4 female, 3 male
- Mean age 5.0 ± 2.3 yrs.
- Median weight. 31.5 kg
- Track 1:
 - Time 24.0 ± 7.1 min
 - Outdoor temperature 83.1°F
 - Humidity 47%
- Track 2
 - Time 25.2 ± 16.0 min
 - Outdoor temperature 90.3°F
 - Humidity 38%

Statistical Analysis

Linear mixed-effects models are being used to assess the impact of hydration method and other factors on changes in blood and urine parameters, weight, and body temperature during each working session. Changes are defined as post-exercise value (after the first track and after the second track are being evaluated) minus pre-exercise value. Full models will include all factors.

The explanatory factors tested in the full model were:

- Hydration strategy
- Average activity count
- Sex
- Breed
- Body weight
- Liquid intake (ml/kg/hr)
- Urine specific gravity
- Ambient temperature
- Humidity
- Hours from last meal
- Housing strategy (indoors vs outdoors)
- Days since last worked

Preliminary Results

- 1) Body weight: There was no significant effect of hydration strategy or time on change in body weight.
- 2) Fatigue: Total activity counts/track were not influenced by hydration strategy but they were influenced by the number of days since the dog last worked ($p=0.05$), the number of hours since being fed ($p=0.007$), total track time ($p<0.0001$), the humidity ($p=0.002$), and the number of weeks since the dog last worked ($p=0.02$).
- 3) Serum electrolytes and lactate: Obtained at 3 times, at the beginning of the day, following their first track, and following their second track using a point of care analysis (ISTAT and lactate meter). Based on preliminary analysis, there was no effect of hydration strategy on lactate, sodium, chloride, or ionized calcium.
- 4) Blood chemistry values: Based on preliminary analysis, hydration method did not impact blood concentrations of glucose, blood urea nitrogen, or creatinine. Both solutions that had buffers (OES and SQ) resulted in a lower total CO_2 after the first track. Creatine kinase over the two track periods was strongly related to total tracking time, but was also influenced by whether a dog was kept in a climate controlled environment or not.
- 5) Hematocrit: Based on preliminary analysis, hydration method did impact hemoconcentration. Although final analysis is pending, the water appears to have performed worse, resulting in higher hematocrits.
- 7) Core body temperature: Peak body temperatures averaged $105.2^\circ F$; however several dogs reached working body temperatures of $> 107^\circ F$. There were no reported illnesses and no dog had to be given fluids for treatment of heat induced injury. Based on preliminary analysis, hydration method did not impact peak working body temperature; however, only in the water group, peak temperature after the second track was significantly higher than after the first track. In addition, and perhaps not surprisingly longer duration of track time was associated with higher temperatures. Labradors had significantly lower peak temperatures than non-Labradors.
- 6) Urine specific gravity and fractional sodium excretion: One unexpected finding was that all dogs started each day with excessively concentrated urine, suggesting that they were dehydrated before they started work. Fractional sodium excretion increased in all dogs and was not influenced by hydration strategy.
- 7) Detection performance: Preliminary review of the track times did not reveal an impact of hydration strategy on track time, when controlling for the individual dog and the track conditions.

Amendments

In Year 2 following approval by University of Pennsylvania IACUC (Protocol 804293) and USAMRMC (USAMRMC Proposal Number SO120002), we removed 2 students from the protocol and added one additional student. We included the study site of El Paso, TX, added 5 additional dogs to the study, and added the use of OES flavoring as a treatment group.

4. KEY RESEARCH ACCOMPLISHMENTS

Year 1

- Accomplishment #1 - Completed the pilot study
- Accomplishment #2 - Demonstrated the safety of all 3 hydration methods
- Accomplishment #3 - Determined that prior conditioning to work and environment decreases the need for special hydration strategies

Year 2

- Accomplishment #1 - Completed data collection for Year 2 of the study
- Accomplishment #2 - Demonstrated the safety of all 4 hydration methods
- Accomplishment #3 - Documented that these dogs are dehydrated prior to starting work

5. CONCLUSIONS

Year 1

Year 1 of this study found that in dogs conditioned to work in the hot and humid environment of the Texas border, there was no detectable influence of hydration strategy on any parameter except fluid consumption, end of work ionized calcium, and total CO₂. The changes in blood values, while reaching statistical significance, did not have clinically significant changes. There were no adverse effects of any hydration strategy. Currently, research does not provide any scientific direction for utilization of hydration protocols.

Considerations implemented in Year 2 included:

- 1) Reformulation of oral electrolyte solution (Hydrolyte™) with lower Na and higher K.
- 2) Evaluate the addition of just the flavor enhancing component of the oral electrolyte solution.

The impact of a hot and humid environment did not, in itself, cause a hydration challenge to dogs that had been properly trained, were in good physical condition, and acclimated.

Year 2

Preliminary analysis of data collected in Year 2 found that hydration strategy did not impact performance or physiology in dogs conditioned for tracking work in the hot and relatively arid environment of the El Paso, TX Canine Training Station. No adverse effects of any strategy were identified. No performance enhancement could be detected with any strategy; however, palatability of the oral electrolyte solution remained high and was associated with a higher handler satisfaction. Dogs working in hot environments can generate core body temperatures in excess of 105.2 (often considered a sign of heat stroke) without adverse consequences. Preliminary analysis suggests that dogs that ate closer to the time of tracking had decreased activity counts suggesting the timing of feeding is important for performance. In a desert environment, higher humidity was associated with increased activity. Preliminary evaluation suggests that dogs that had not been working regularly had lower activity counts (the first day of

the study). The highest activity counts were obtained if the dog had 2 days since the last working day. This suggests that conditioning is critical to maintain performance. The optimal frequency of conditioning is unknown as there were no days in which the dogs worked sequentially; all study days were either 2 or 4 days apart. Furthermore, there is evidence to suggest that acclimation to the environment (no exposure to climate control) may reduce muscle injury, although this warrants further study.

Data collection was completed as planned. The delays resulted from the large amount of data and delays in completing the analysis; warranting a no cost extension. The data has all been reviewed and analysis has neared completion and the manuscripts are in preparation.

6. PUBLICATIONS, ABSTRACTS, AND PRESENTATIONS

Invited Abstract Presentations

- International Working Dog Association, Oct 15, 2013 San Antonio TX
- Special Operations Medical Association Dec 16, 2013 Tampa FL
- Military S&T Conference, Raleigh, NC July 30, 2014
- International Working Dog Association, Mar 26, 2015 Le Grande-Motte, France

Oral presentation

- 2013 USASOC Military Working Dog S&T Workshop, Raleigh NC

7. INVENTIONS, PATENTS, AND LICENSES

None to report

8. REPORTABLE OUTCOMES

Year 1

Manuscript in preparation

Year 2

Manuscripts in preparation.

9. OTHER ACHIEVEMENTS

None to report

10. REFERENCES

Pinheiro, J., Bates, D., DebRoy, S., & Sarkar, D. (2013). R Development Core Team (2012) nlme: linear and nonlinear mixed effects models. R package version 3.1-103. R Foundation for Statistical Computing, Vienna.

11. APPENDICES

- Poster
- PDF of presentation at International Working Dog Conference Mar 2015
- Personnel summary

MAINTAINING HYDRATION OF DOGS IN HOT WORKING ENVIRONMENTS

JL Nord¹, E Hare¹, SM Palermo¹, KM Kelsey¹, TA Darling², K Schmidt³, CM Otto¹

1. Penn Vet Working Dog Center, School of Veterinary Medicine, Univ of Pennsylvania, Philadelphia, PA
2. Veterinary Medical Assistance Teams, 3. College of Vet Med, Washington State Univ. Pullman WA



Introduction

- Military and other working dogs are heavily relied upon to protect our national security and respond to disasters.
- Working dogs are subject to adverse environmental conditions, and dehydration is a complication of these intense working environments.
- Hot environments and high humidity levels can lead to dehydration.
- Dog handlers currently use water (W), subcutaneous fluids (SQ), and oral electrolyte solutions (OES) to prevent dehydration.
- **Safety and efficacy of these hydration strategies have not been previously studied.**
- The aim of this study was to compare the effects of three hydration strategies on hydration status and performance in Border Patrol dogs screening vehicles on the Texas border in the summer.



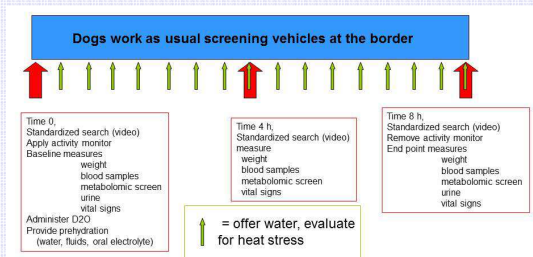
Hypothesis

We hypothesized that for all hydration parameters, there would be no difference between the oral electrolyte solution (OES), water (W) and subcutaneous fluids (SQ) groups.



Methods

- Cross over design study using 7 vehicle screening canines from the Rio Grande Valley sector of the U.S. Customs and Border Protection.
- Each dog was randomly assigned to each of three prehydration strategies: oral water (10 ml/kg), oral electrolyte solution (OES, Hydrolyte™, 10 ml/kg), or subcutaneous balanced electrolyte solution (Plasmalyte, 15 ml/kg) in random order.



- At the beginning of each day dogs received:
 - Full physical examination, 0.2 ml/kg of deuterium orally, placement of activity monitors (Actical), and prehydration
- At the beginning, middle, and end of each work day the following parameters were obtained:
 - Blood for electrolytes (i-STAT® CHEM8+), lactate (Scout), total body water
 - Urine for specific gravity, fractional Na excretion, and microalbuminuria (E.R.D. - HealthScreen®)
 - Body weight
 - Pulse (AliveCor), respiratory rate, temperature (CorTemp®)
- At the beginning and end of each work day a standardized search was conducted
- Dogs were offered 10 ml/kg water every 30 minutes
 - If dogs in the OES group failed to drink >3 ml/kg of water, they were offered 10 ml/kg of OES

Statistics

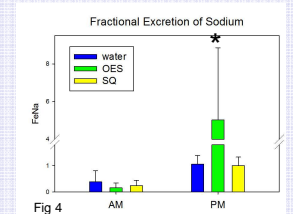
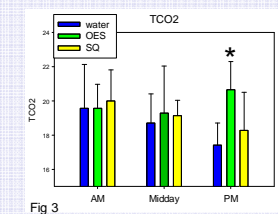
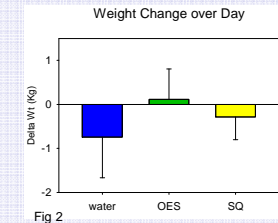
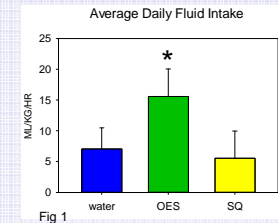
- Changes in each dog's weight, core temperature, and blood parameters were analyzed using linear models in R.
- The effects of hydration method, demographic variables (sex, breed, age), dog's weight, changes in pulse and urine specific gravity during the test period, and ambient temperature and humidity were included in the full model for each outcome.
- Generalized linear models were used when outcomes had distributions that deviated markedly from normal based on measures of skewness and kurtosis.

Results

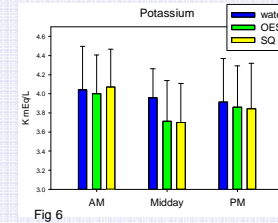
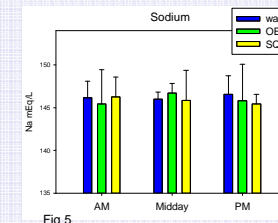
7 dogs

Belgian Malinois n=5, German Shepherd n=2
3 female, 4 male

Mean age (yrs) 5.5 ± 1.9
Mean weight (kg) 30.5 ± 4.2
Median work time (hrs) 6 (IQR 5,6)
Median Temp (°F) 84.8° (range 74.0-99.9°)
Median Humidity 70% (range 39-100%)
Median wind speed (mph) 5.6, (range 0-18)
Median activity (counts/hr) 42,352 (range 27,972-66,528)



Dogs in the OES group drank significantly more ($p < 0.001$) than any other group (Fig 1). Method of hydration did not significantly impact changes in dog's temperature and weight (Fig 2) during the training period. Most blood parameters were unaffected by hydration strategy, except for TCO_2 (Fig 3), values were greater in OES than for SQ ($p = 0.09$), or for water ($p = 0.09$). The change in fractional excretion of sodium was significantly higher following OES treatment ($p = 0.016$) (Fig 4); however blood Na and K were unaffected (Fig 5 and 6)



Conclusions


In dogs conditioned to work in the hot and humid environment of the TX border, there was no detectable influence of hydration strategy on any parameter except fluid consumption, TCO_2 , and fractional Na excretion.

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PennVet
Working Dog Center


PREHYDRATION OF WORKING DOGS

CM Otto¹, L Brunker², JL Nord¹, E Hare¹, SM Palermo¹, KM Kelsey¹, TA Darling², K Schmidt³
 1. Penn Vet Working Dog Center, School of Veterinary Medicine, Univ of Pennsylvania, Philadelphia, PA 2. Veterinary Medical Assistance Teams, 3. College of Vet Med, Washington State Univ, Pullman WA




Funded by
USSOCOM W81XWH-13-1-0038

- Dog handlers currently use
 - water (W),
 - subcutaneous fluids (SQ),
 - oral electrolyte solutions (OES)
 to prevent dehydration




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Strategies:



Subcutaneous (SQ) fluids



water



Oral electrolyte solution

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- Safety and efficacy of these hydration strategies have not been previously studied!



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Aim 1


- ▶ Compare 3 hydration strategies on hydration and performance in Border Patrol dogs screening vehicles on the Texas border in the summer.




Study design

Cross over design:

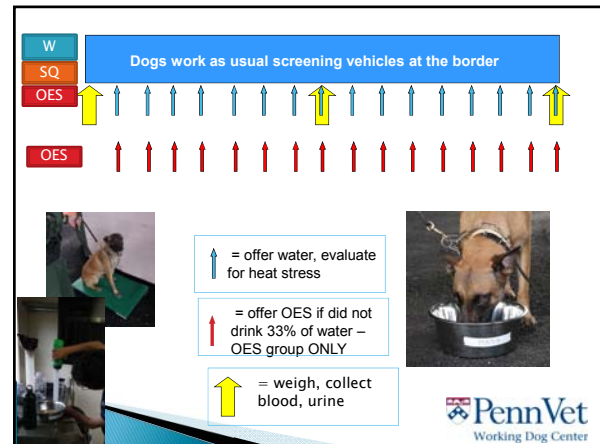
- 7 vehicle screening canines
- Rio Grande Sector (Kingsville Station)
- Working 30 min shifts
- Each dog was randomly assigned to each of three prehydration.



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Vehicle Screening Hydration:

- ▶ Water –
 - offered at 10 ml/kg initially and every 30 min
- ▶ Subcutaneous fluids –
 - Balanced electrolyte (Plasmalyte®) given 15 ml/kg initially and then water offered 10 ml/kg every 30 min
- ▶ Oral electrolyte (OES)
 - (Hydrolyte®) offered at 10 ml/kg initially and then water (10 ml/kg) offered every 30 min
 - Failure to drink >3ml/kg of water ⇒ offer 10 ml/kg OES



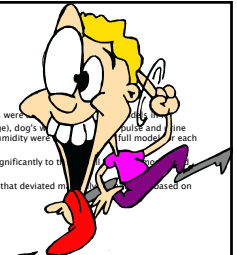
Parameters

- Blood
 - Electrolytes (Na, K, Cl)
 - lactate
- Urine concentration and Na
- Body weight
- Pulse, respiratory rate, core temperature
- Activity



Statistics

- Changes in each dog's weight, core temperature, and blood parameters were analyzed using a full model for each outcome.
- The effects of hydration method, demographic variables (sex, breed, age), dog's specific gravity during the test period, and ambient temperature and humidity were included in a refined model.
- The drop1 function was used to determine which factors contributed significantly to those factors were included in a refined model.
- Generalized linear models were used when outcomes had distributions that deviated from normality, based on measures of skewness and kurtosis.



Basically we compared the response to each of the treatments over the day for each dog. This allowed us to account for the unique behavior of individuals



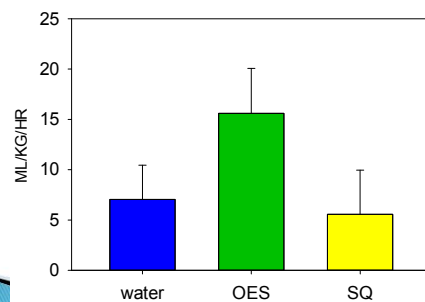
Results

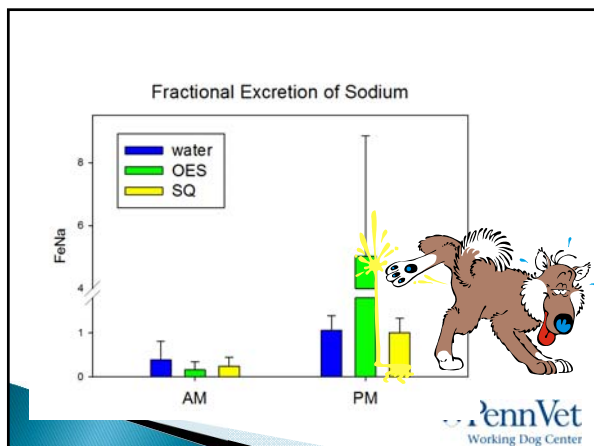
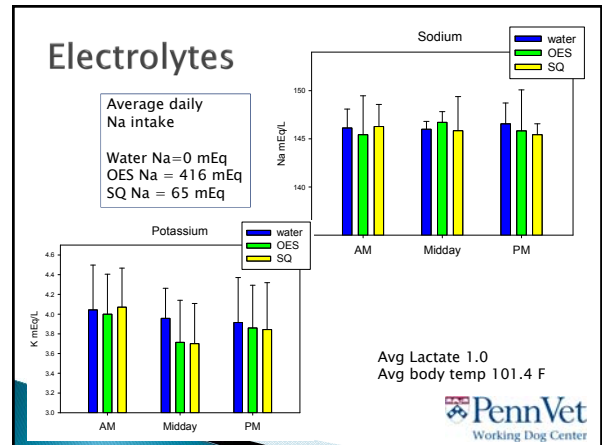
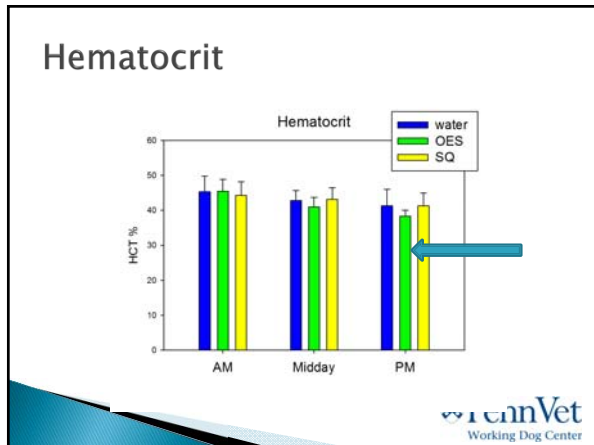
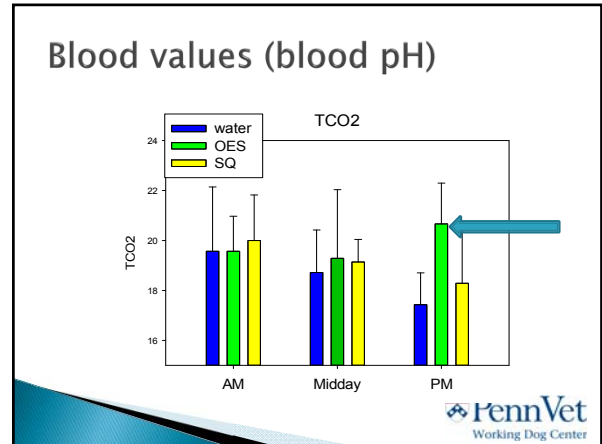
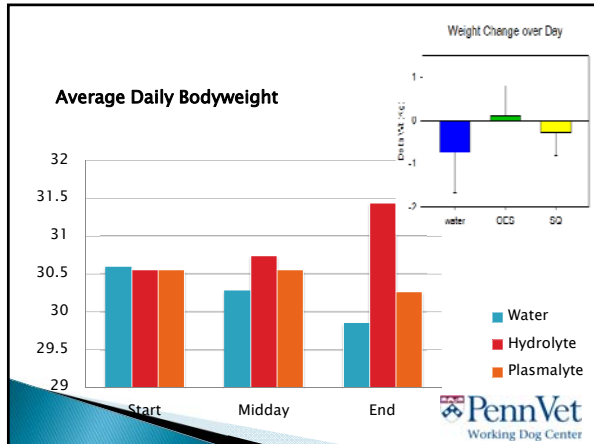
- ▶ N= 7 dogs,
- ▶ 3 female, 4 male
- ▶ Mean age 5.5 ± 1.9 yrs
- ▶ Mean Wt 30.5 Kg ± 4.2
- ▶ Median work time 6 hours (IQR 5,6)
- ▶ Median Temp 84.8F (range 74.0-99.9)
- ▶ Median Humidity 70% (range 39-100)
- ▶ Windspeed – median 5.6 mph, (range 0-18)



Fluid intake

Average Daily Fluid Intake

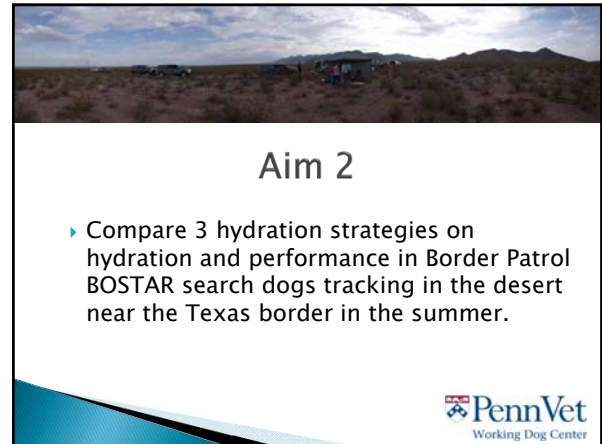




Conclusions

- ▶ In these dogs conditioned to work in the hot and humid environment of the TX border,
- ▶ All strategies were safe
- ▶ Oral electrolyte was more palatable, leading to increased consumption
 - Higher TCO₂,
 - Lower HCT,
 - Higher body weight,
 - Higher Na excretion
 - less concentrated urine

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- ▶ Compare 3 hydration strategies on hydration and performance in Border Patrol BOSTAR search dogs tracking in the desert near the Texas border in the summer.

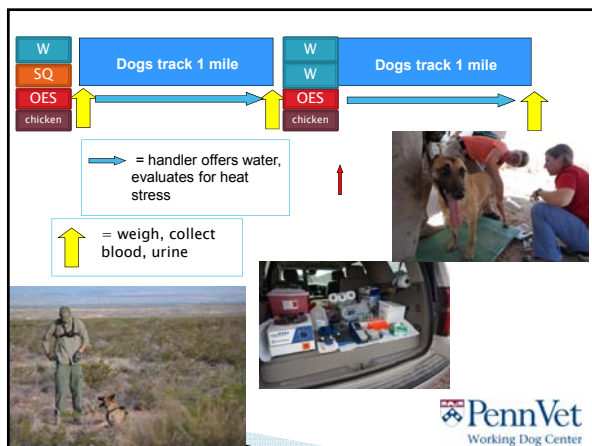
Study design

Cross over study:

- 7 tracking canines
- El Paso Sector
- Two 1 mile tracks/day
- Dogs randomly assigned to each of three prehydration strategies.

Tracking Hydration:

- ▶ **Preload prior to track**
 - Water – offered at 10 ml/kg
 - Subcutaneous fluids – Balanced electrolyte (Plasmalyte®) at 15 ml/kg
 - Oral electrolyte (OES) –(Hydrolyte® –30% reduction in Na, 30% increase in K) offered at 10 ml/kg
 - Flavoring (Hydrolyte® chicken flavor, no electrolytes) offered at 10 ml/kg
- ▶ **Maintenance during track**
 - Water offered as determined by the handler

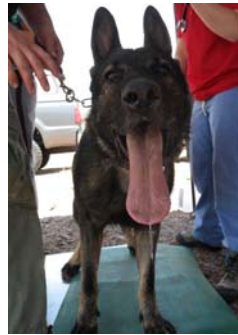


Parameters

- Blood
 - Electrolytes (Na, K, Cl)
 - lactate
- Urine concentration and Na
- Body weight
- Pulse, respiratory rate, core temperature
- Activity

Results

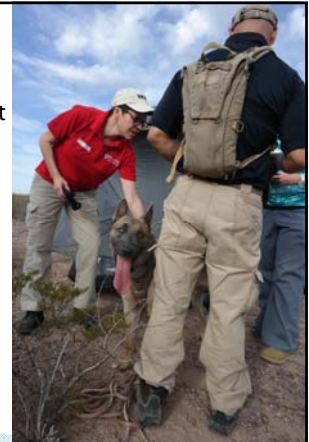
- ▶ N= 7 dogs,
- ▶ 4 female, 3 male
- ▶ Mean age 5.0 ± 2.3 yrs
- ▶ Median wt 31.5 Kg
- ▶ Track 1:
 - Time 24.0 ± 7.1 min
 - outdoor T 28.4°C
 - humidity 47%
- ▶ Track 2
 - Time 25.2 ± 16.0 min
 - outdoor T 32.4°C
 - humidity 38%



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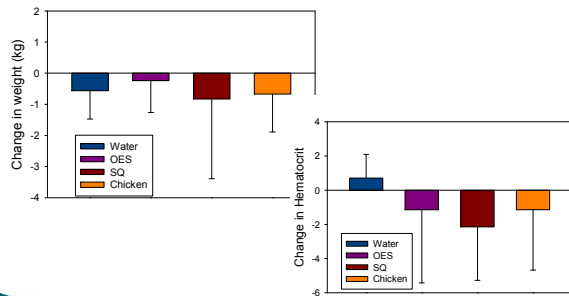
Preliminary RESULTS

- ▶ Every dog started out dehydrated . . .
 - Median USG 1.065



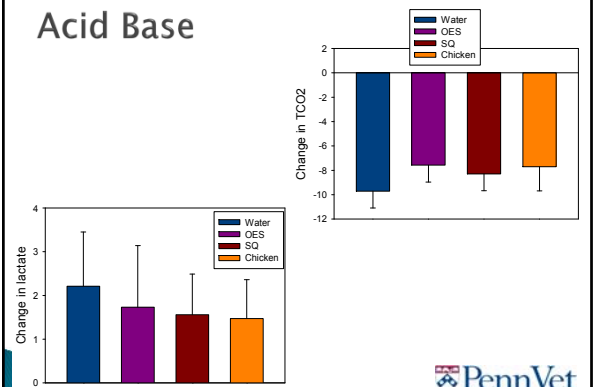
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Hydration Parameters



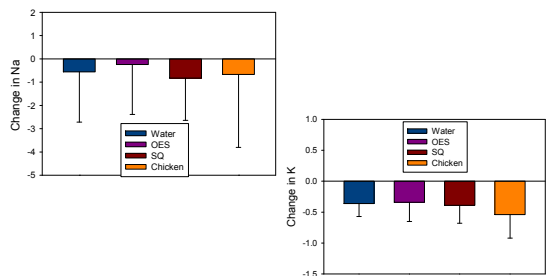
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Acid Base



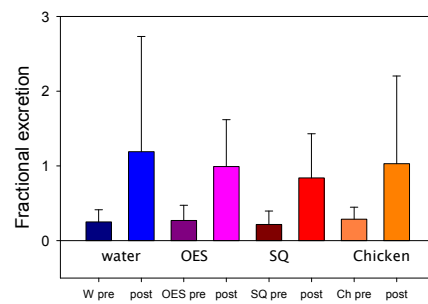
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Change in electrolytes

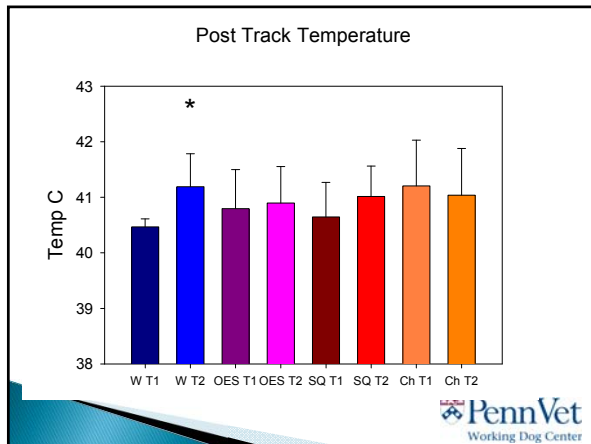


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Pre and Post Fractional Excretion of Sodium

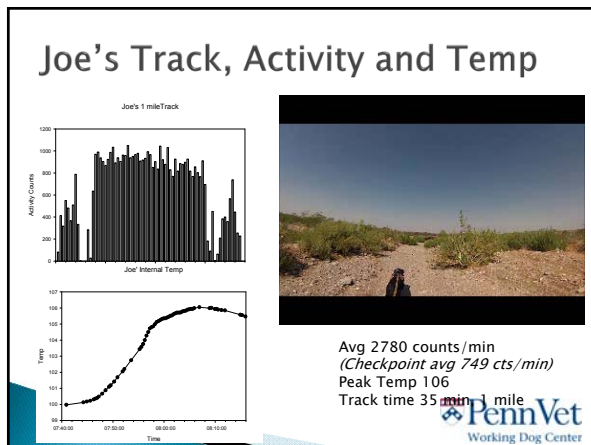


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Conclusions

- ▶ In these dogs conditioned to work in the hot desert environment of the TX border,
- ▶ All strategies were safe
- ▶ Pre-hydration did not have a significant effect on
 - electrolytes
 - lactate
 - maximum temperature
 - body weight
- ▶ Water alone -> increase in T after 2nd track



Personnel Summary

Name:	Cynthia Otto
Project Role:	PI
Researcher Identifier (e.g. ORCID ID):	
Nearest person month worked:	1.7 in Year 1, 2.2 in Year 2
Contribution to Project:	Designed study, collected data, interpreted data
Funding Support:	none
Name:	Kathleen Kelsey
Project Role:	Research Coordinator
Researcher Identifier (e.g. ORCID ID):	
Nearest person month worked:	3.6 in Year 1, 4.9 in Year 2
Contribution to Project:	Database development, data acquisition, study coordination
Funding Support:	none
Name:	Jess Nord
Project Role:	Research Technician/Student
Researcher Identifier (e.g. ORCID ID):	
Nearest person month worked:	3 in Year 1
Contribution to Project:	Coordinated supplies, collected data in Year 1
Funding Support:	none
Name:	Leslie Bruner
Project Role:	Research Technician/Student
Researcher Identifier (e.g. ORCID ID):	
Nearest person month worked:	3 in Year 2
Contribution to Project:	Coordinated supplies, collected data in Year 2
Funding Support:	none