

# CHANGES OVER TIME IN NEONATES WITH HIE

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# OBJECTIVES

- ▶ Identify normal trends in laboratory values in neonates with HIE.
- ▶ Define neonates who may need further evaluation for end-organ injury.
- ▶ Understand how heart variability can predict inflammation and neurological injury.

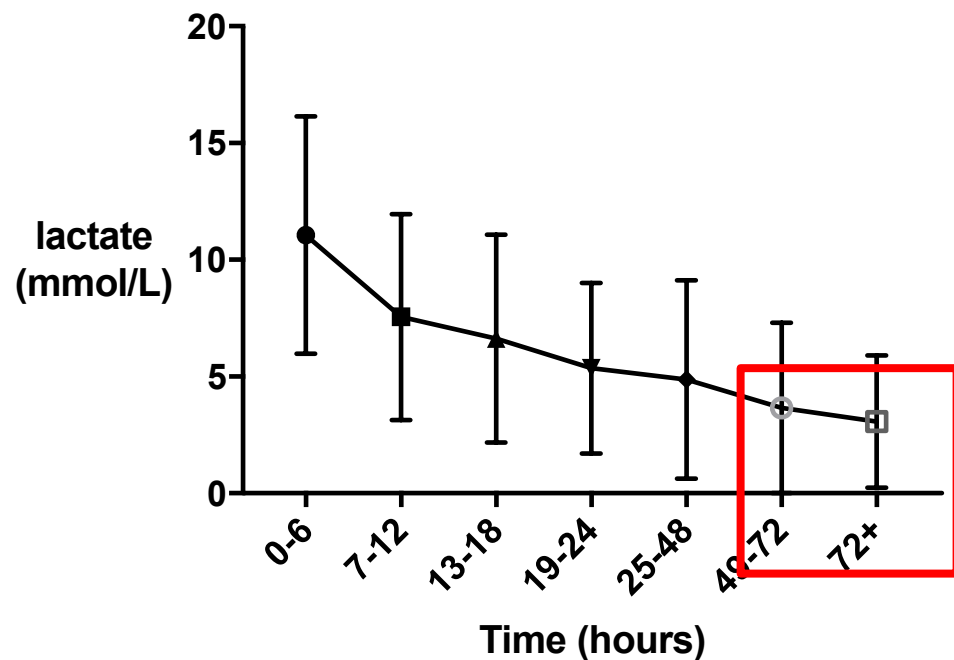


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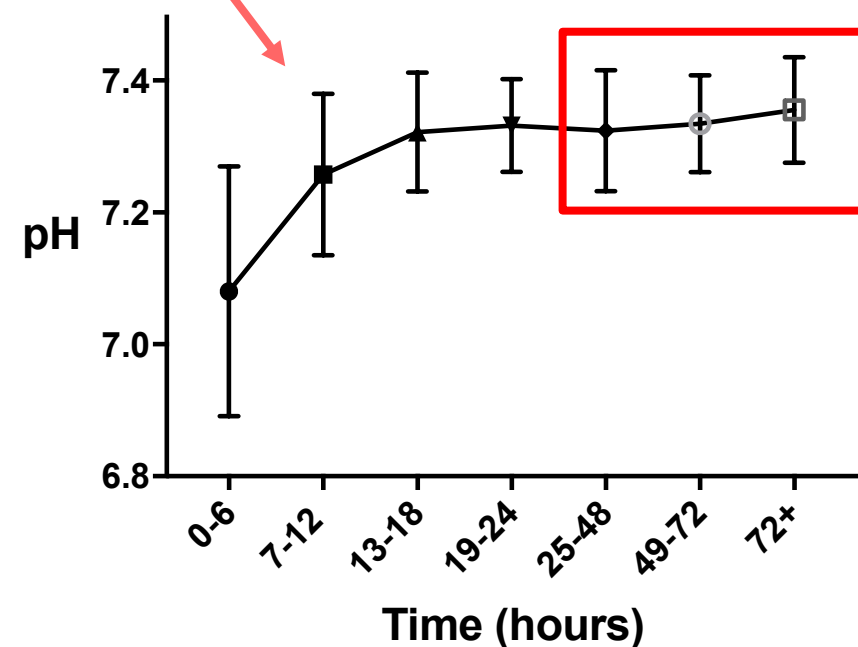


# ACID BASE BALANCE

Lactate over time

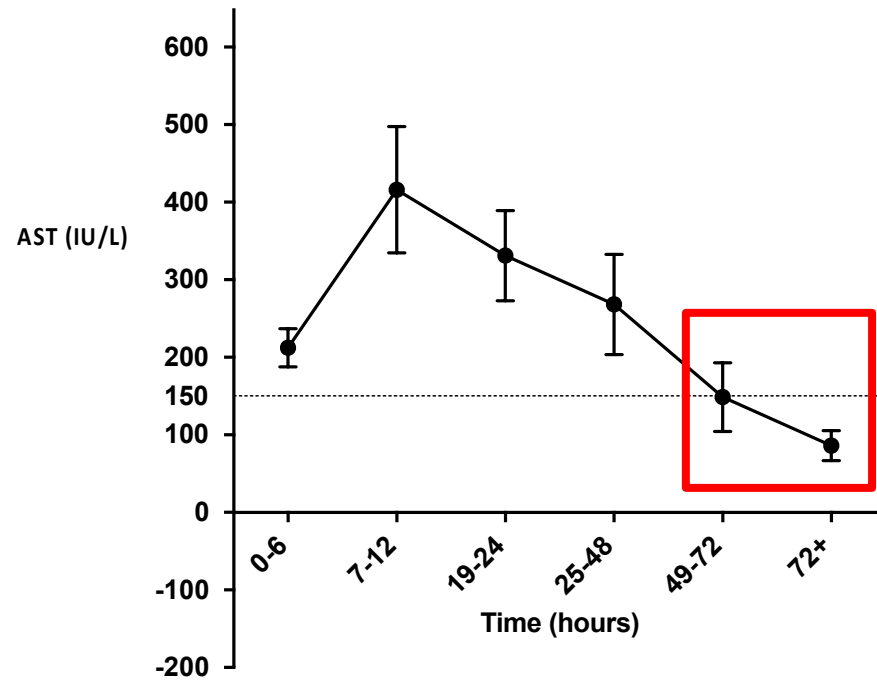


pH over time

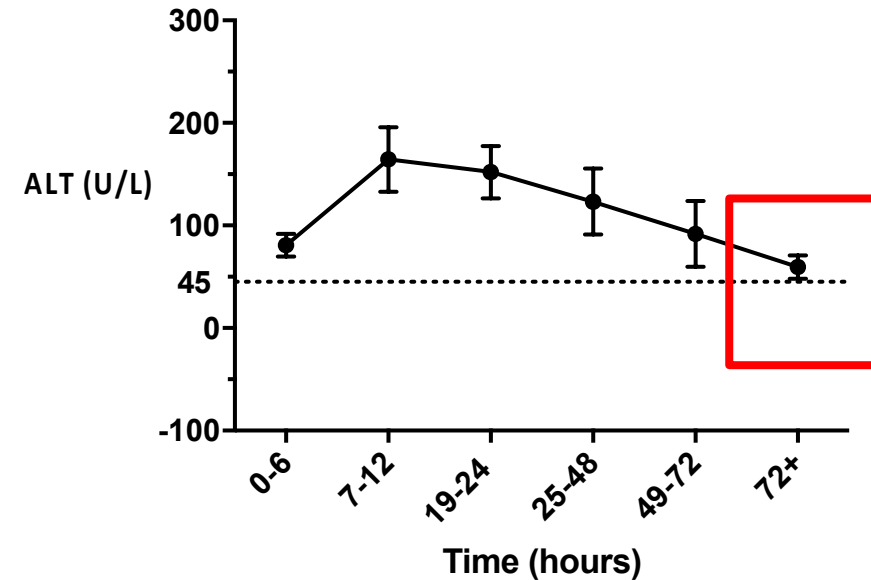


# TRANSAMINASES

Aspartate Aminotransferase (AST) over time

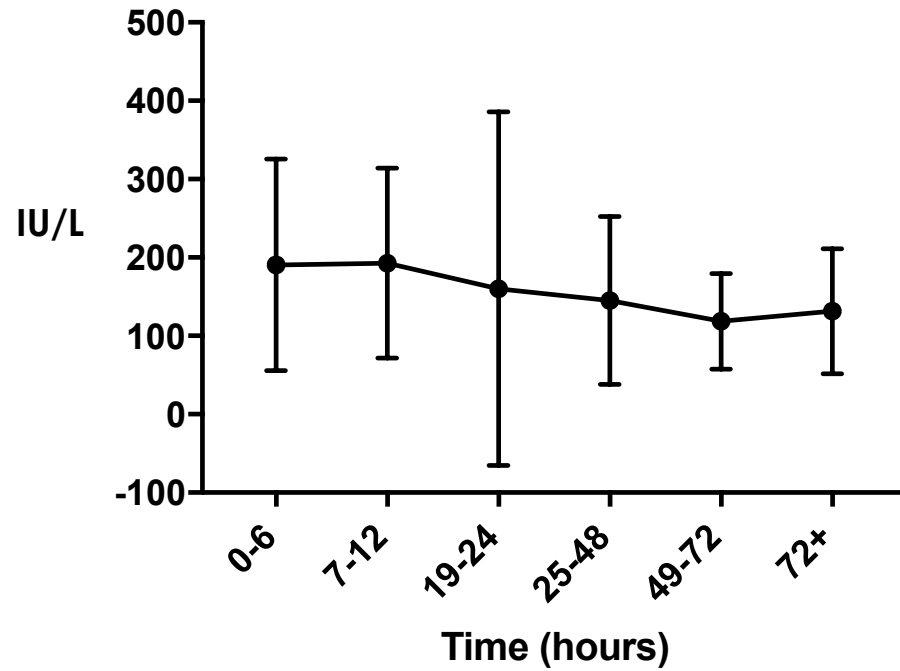


Alanine aminotransferase (ALT) over time

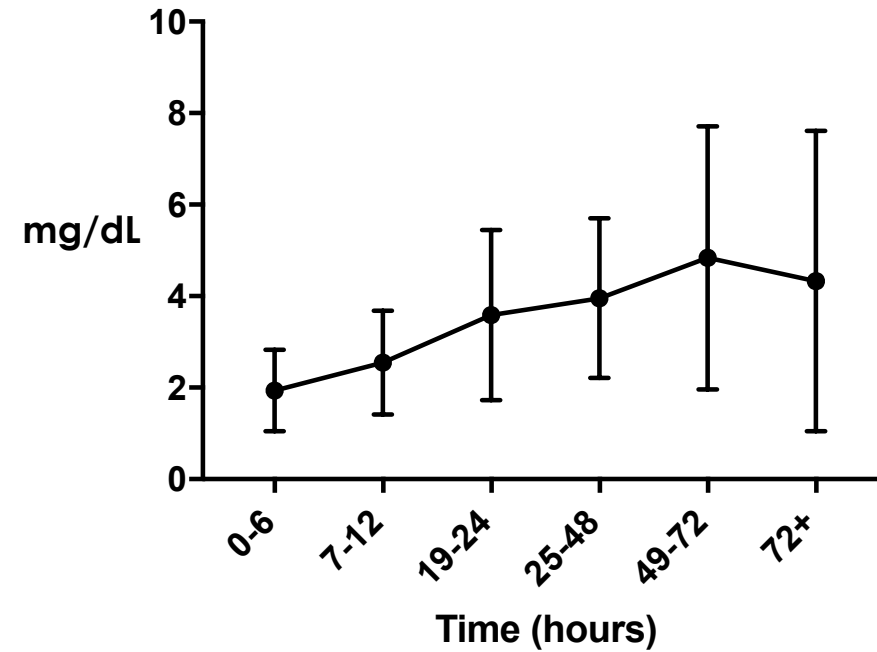


# ALKALINE PHOSPHATASE AND BILIRUBIN

**Alkaline phosphatase over time**

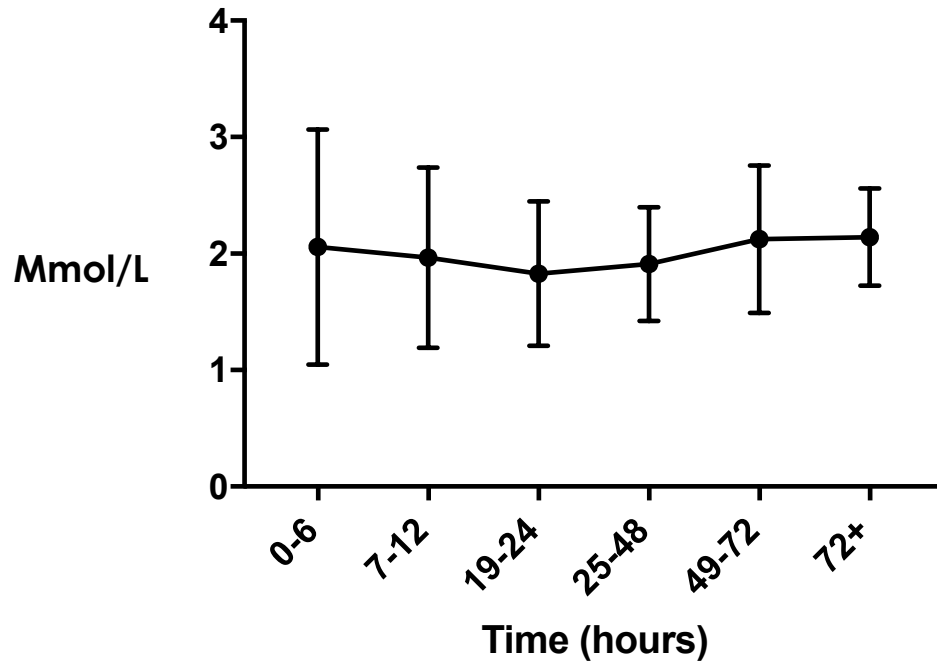


**Total Bilirubin over time**

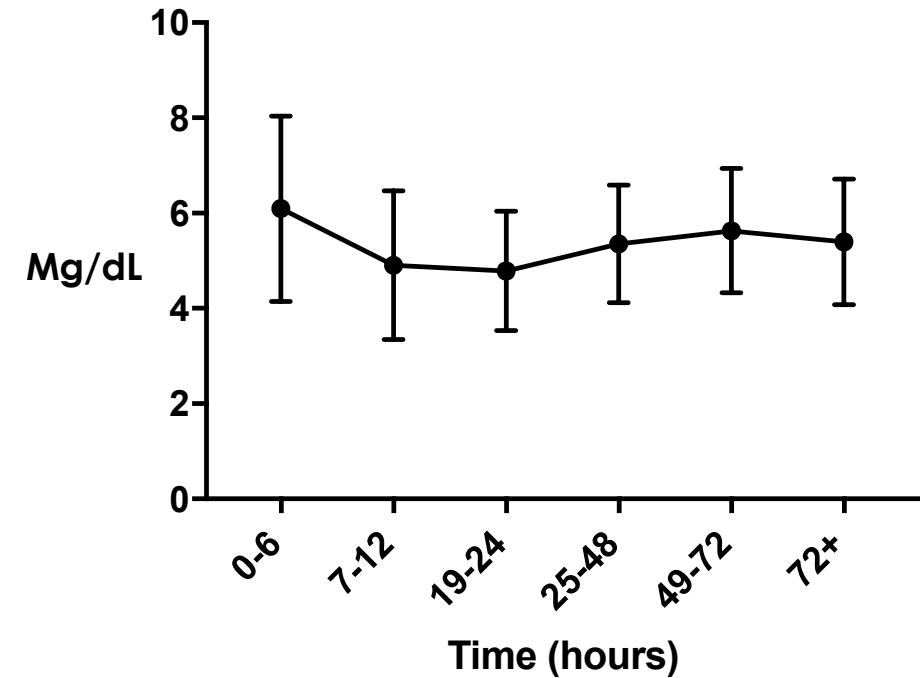


# ELECTROLYTES

magnesium over time



Phosphorus over time



# ARE THERE DIFFERENCES IN THOSE BABIES WHO DO AND WHO DO NOT DEMONSTRATE INJURY ON THEIR MRI?

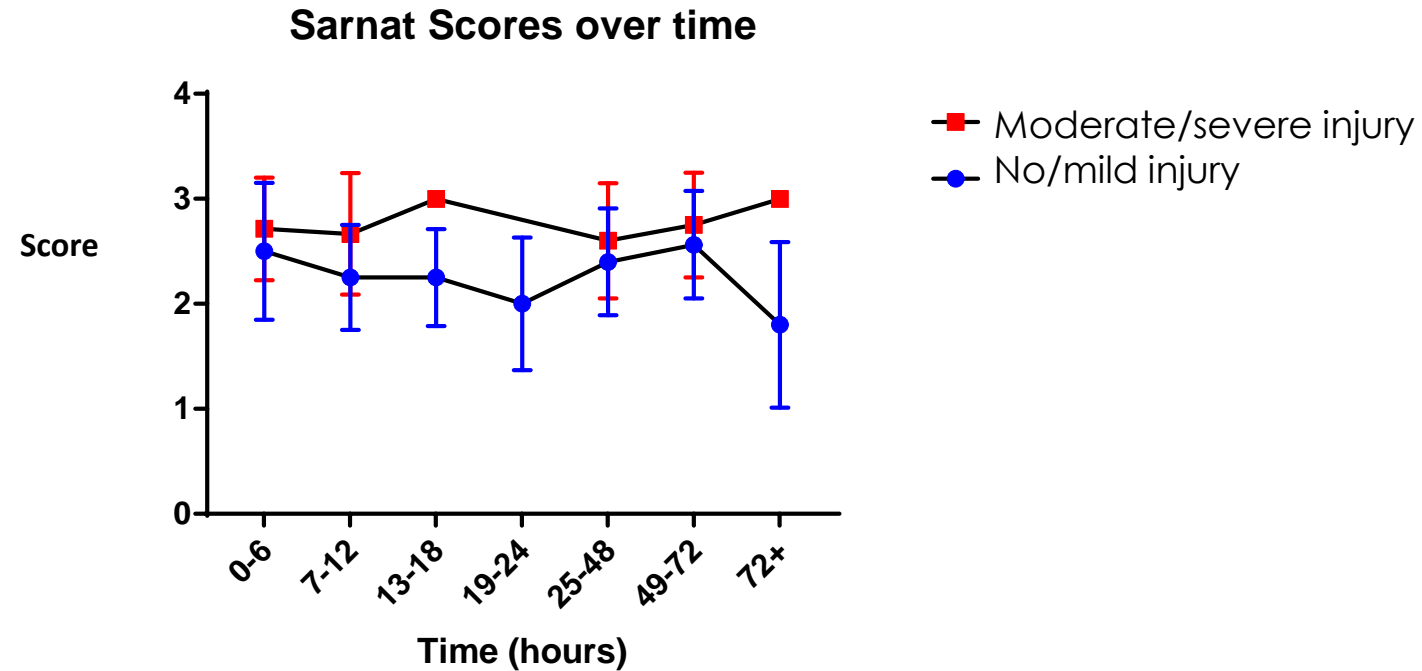


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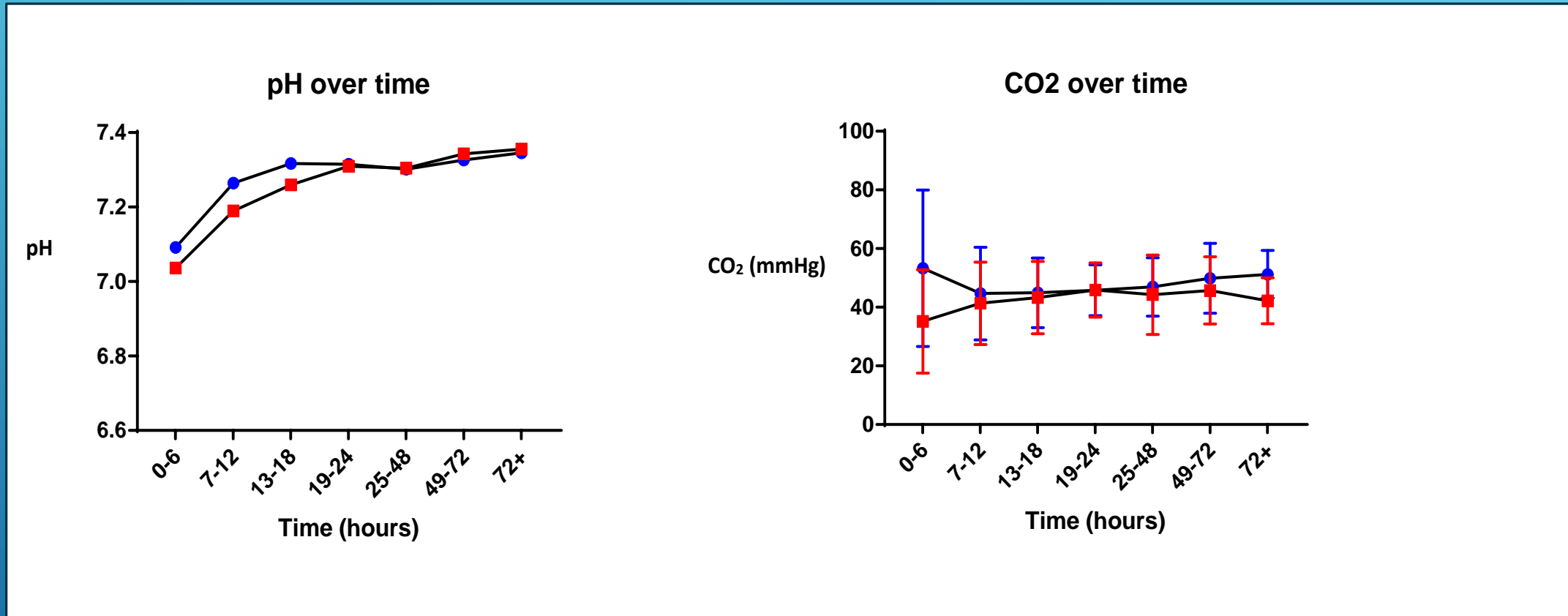


# SARNAT SCORES

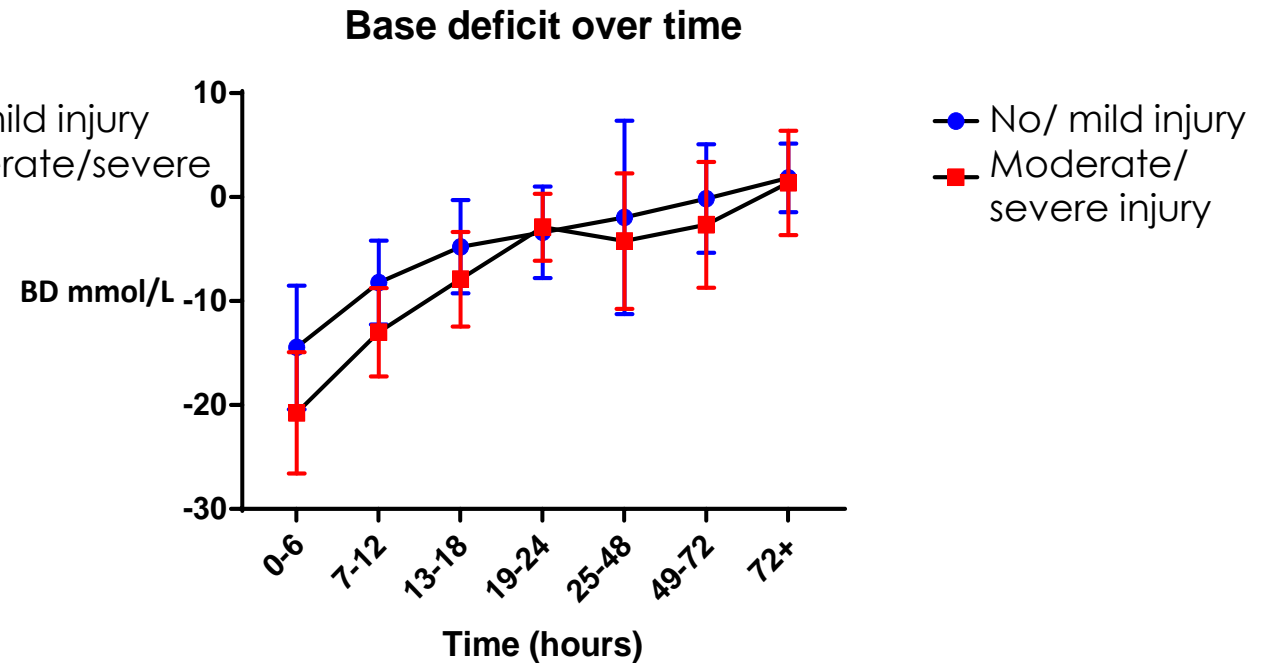
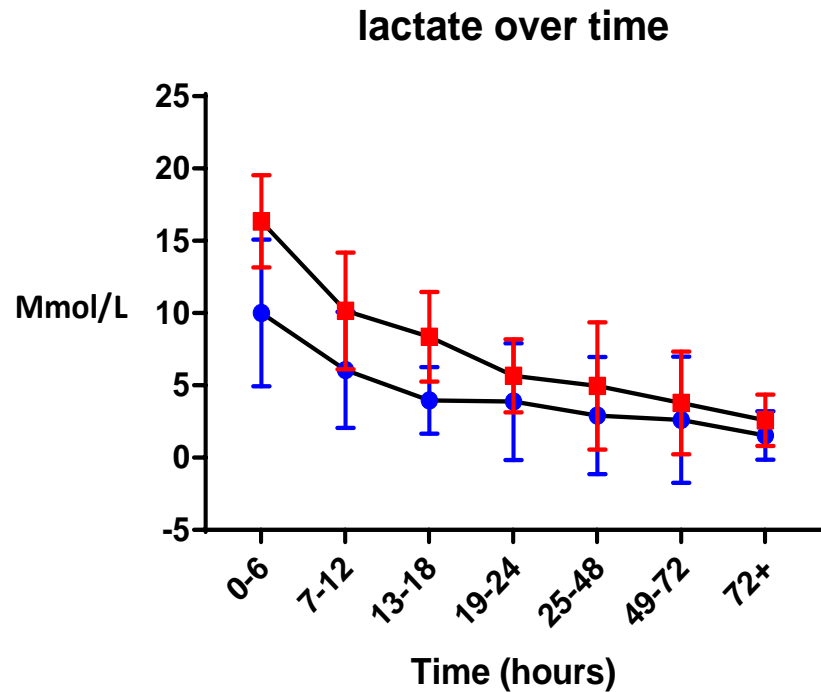




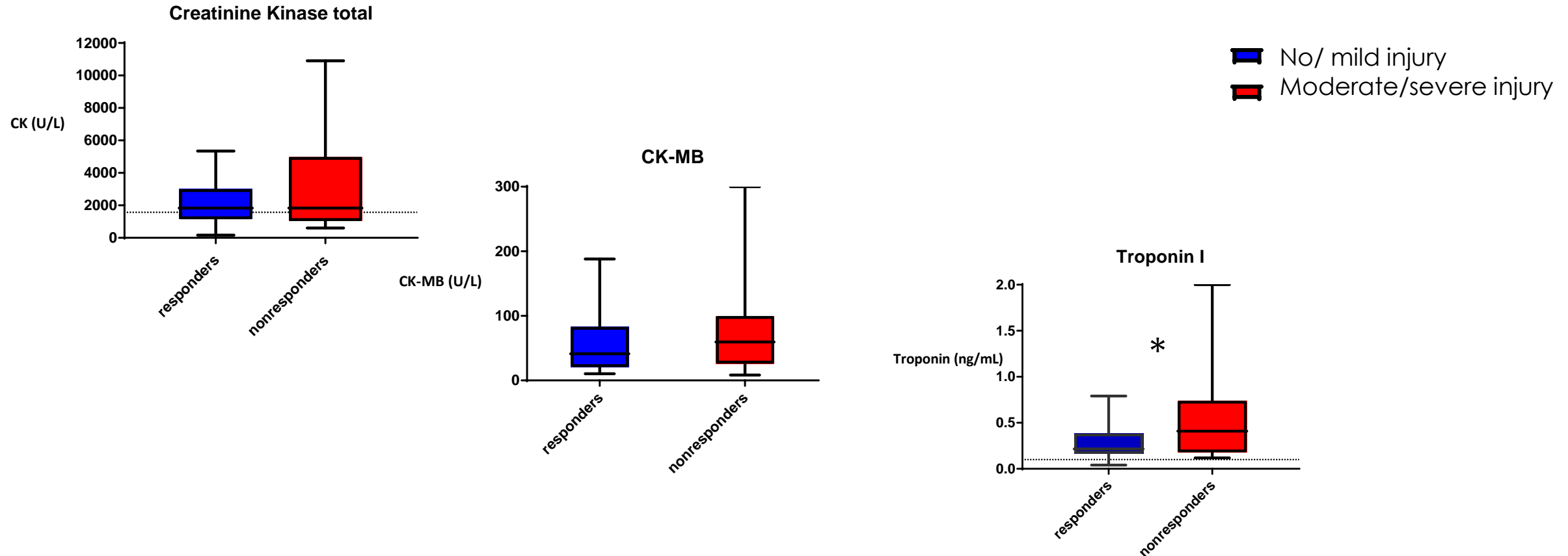
# ACID BASE BALANCE



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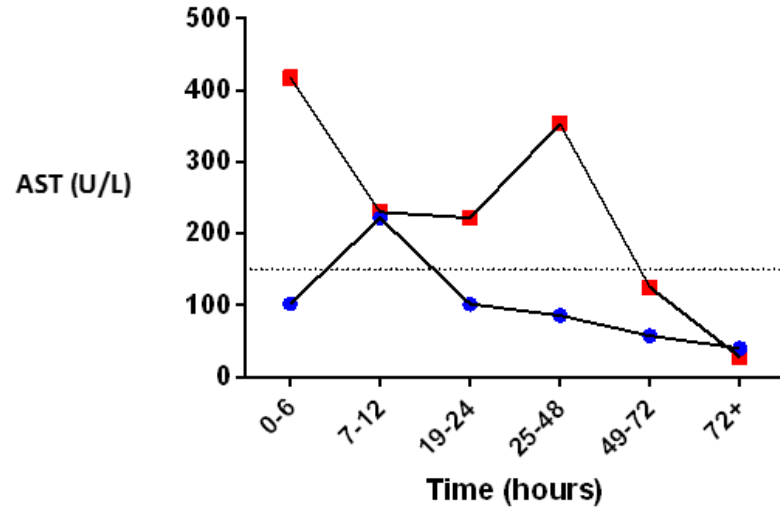


# MARKERS OF CARDIAC ISCHEMIA

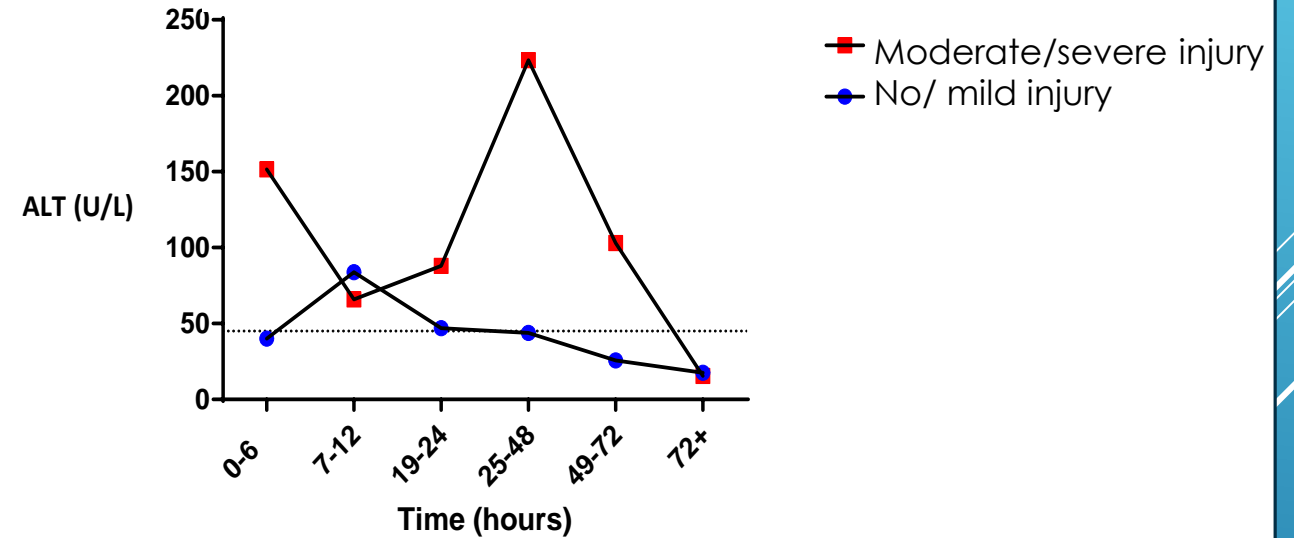


# TRANSAMINASES

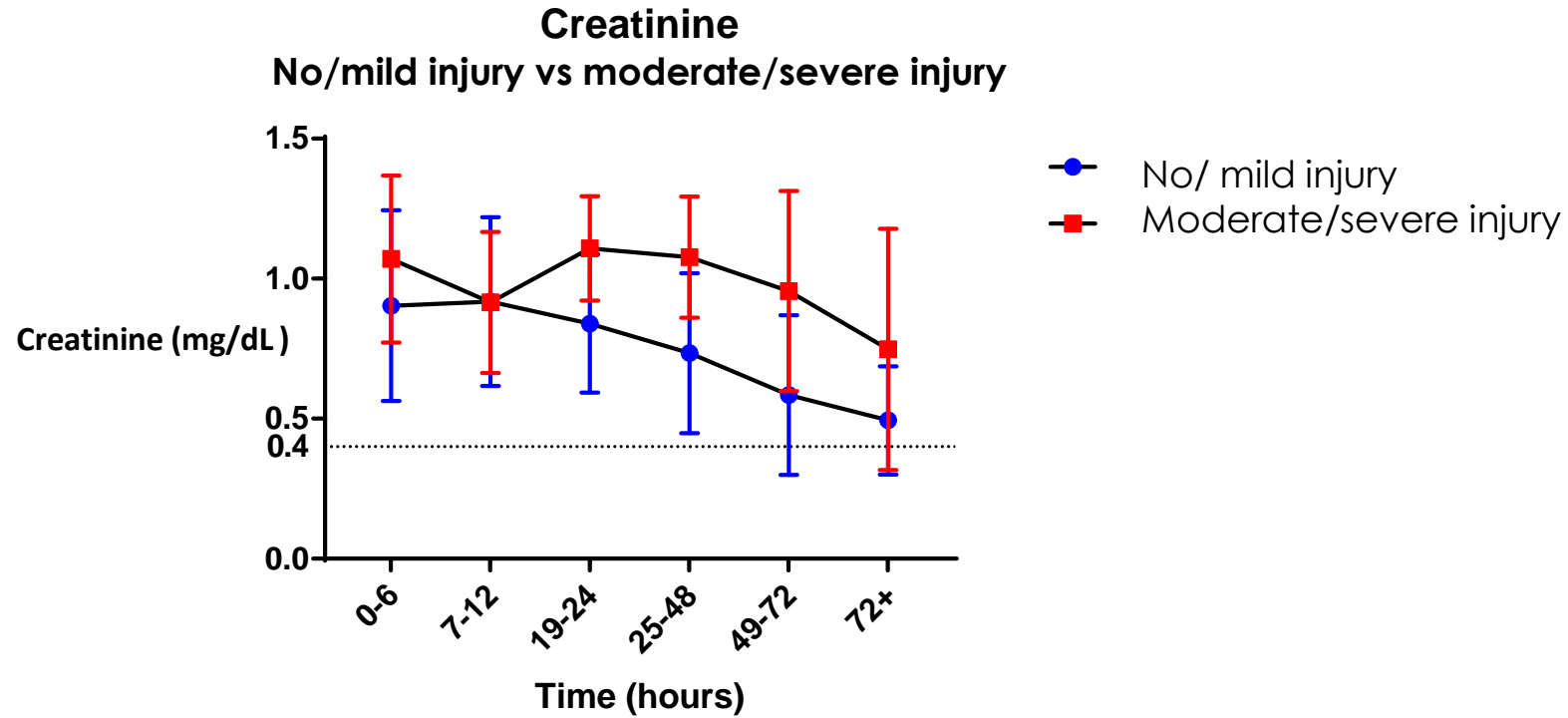
**Aspartate Aminotransferase (AST)**  
No/mild injury vs moderate/severe injury



**Alanine aminotransferase (ALT)**  
No/mild injury vs moderate/severe injury



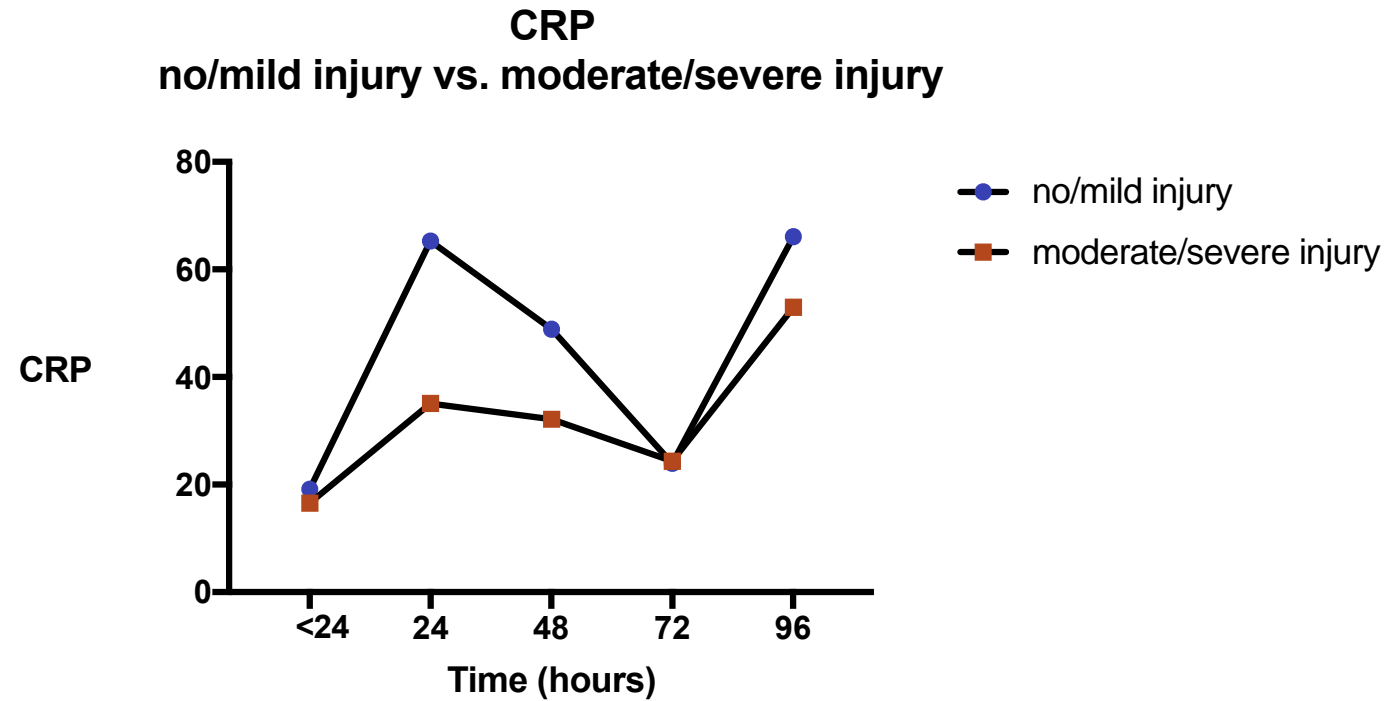
# RENAL FUNCTION



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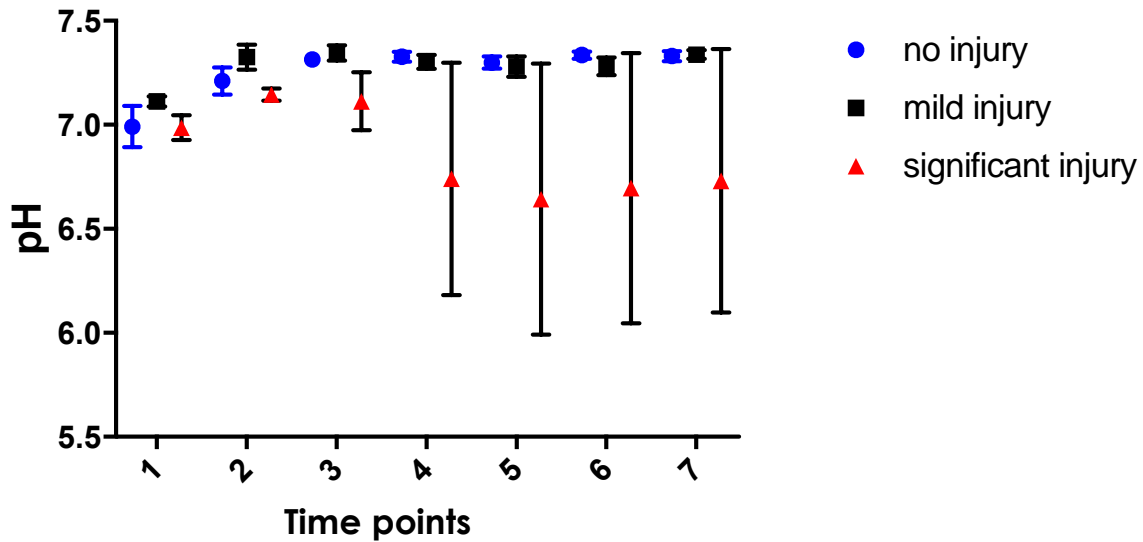
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# C- REACTIVE PROTEIN

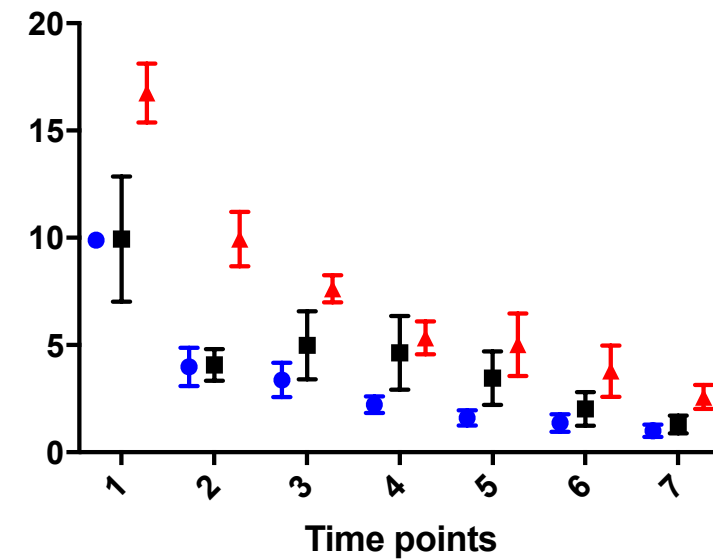


# WHAT ABOUT THE SEVERE BABIES?

pH over time in infants with initial Sarnat of 3



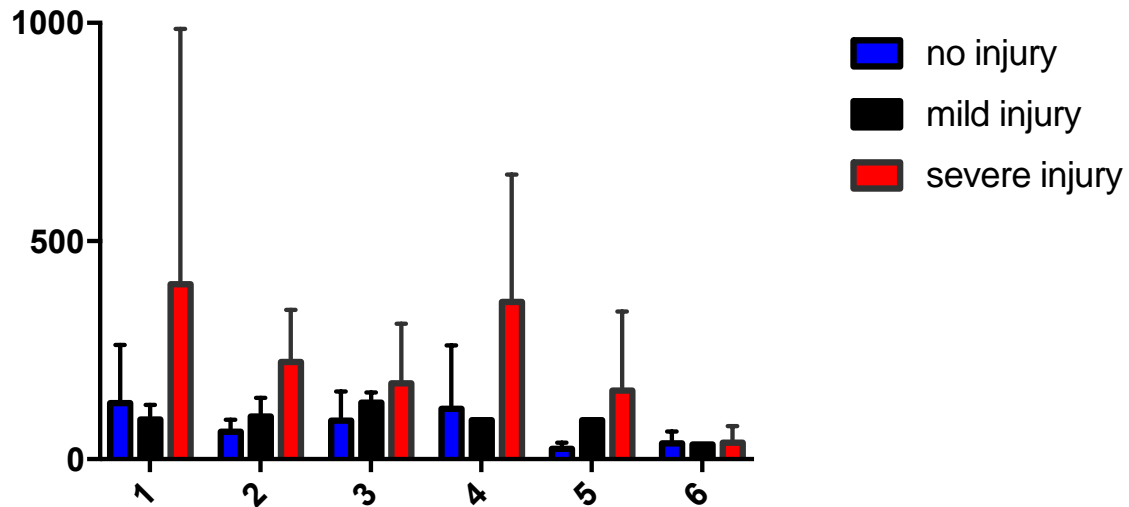
Lactate over time in infants with initial Sarnat of 3



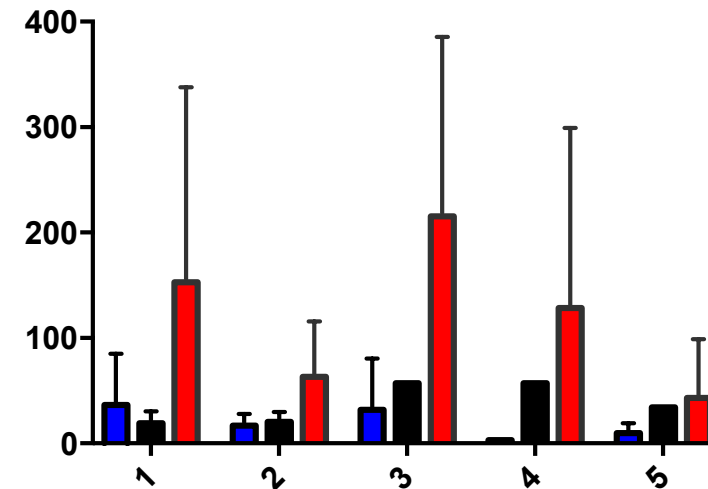


# WHAT ABOUT THE SEVERE BABIES?

sarnat 3 AST over time



sarnat 3 ALT over time



# LAB TREND KEY POINTS

- ▶ Extremes of electrolytes, glucose or acid/base disturbance also worsen prognosis, or are indicators of worse prognosis
- ▶ Babies that do not follow the normal trends should be evaluated for a different pathology
- ▶ Still no definitive marker to predict injury
  - ▶ Could we combine markers?
  - ▶ Is there anything else?

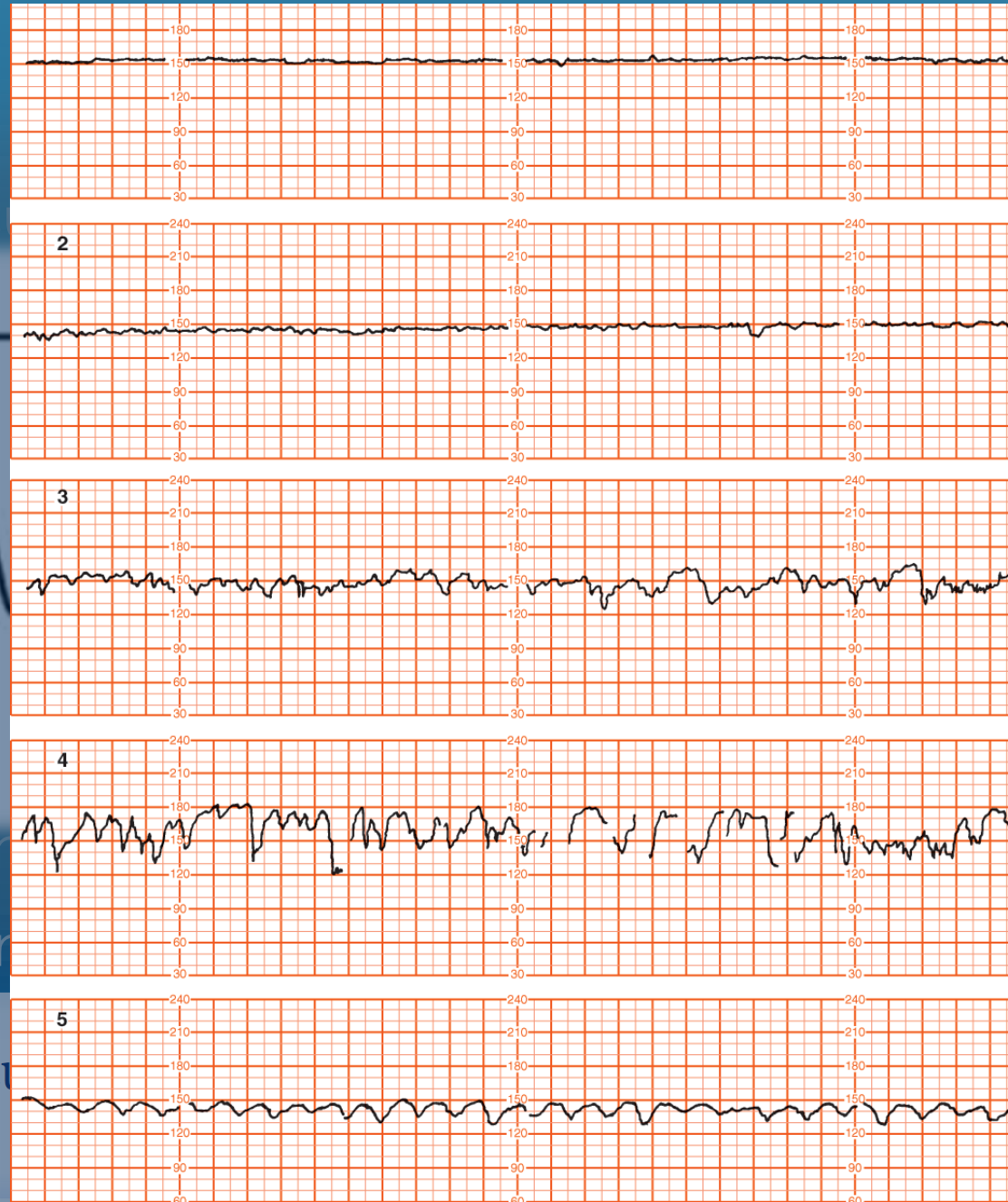
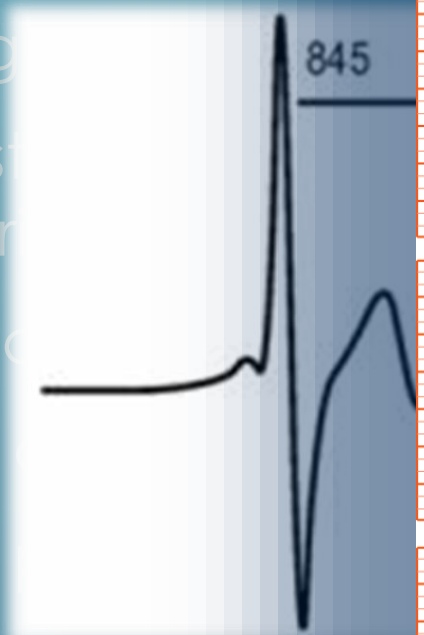


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# HEART RATE

- ▶ HRV is the measure of the regularity of heart rate
- ▶ First derivative of heart rate
- ▶ Since heart rate is a function of time, the first derivative of heart rate is a function of time
- ▶ Predicts brain injury
- ▶ Predicts neonatal outcomes



beats and is



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# FREQUENCY

## High frequency

- Regulated by parasympathetic nervous system (0.3 - 1.0 Hz)

## Low frequency

- Regulated by the sympathetic nervous system (0.04 - 0.20 Hz)



# BENEFITS OF USING HRV AS A BEDSIDE MARKER

- ▶ Non-invasive
- ▶ Quick
- ▶ Continuous information
- ▶ Data in raw form is already being used
  - ▶ Simple conversion



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# HRV IN OTHER DISEASE STATES

Disease Process	High frequency (HF)	Low frequency (LF)	LF/HF ratio
HIE (before cooling)	↑	↓	-
Adults with sepsis	-	↓	↓
Children with increased ICP	-	↓	↓
Rheumatoid Arthritis/ Lupus	↓	↓	↑



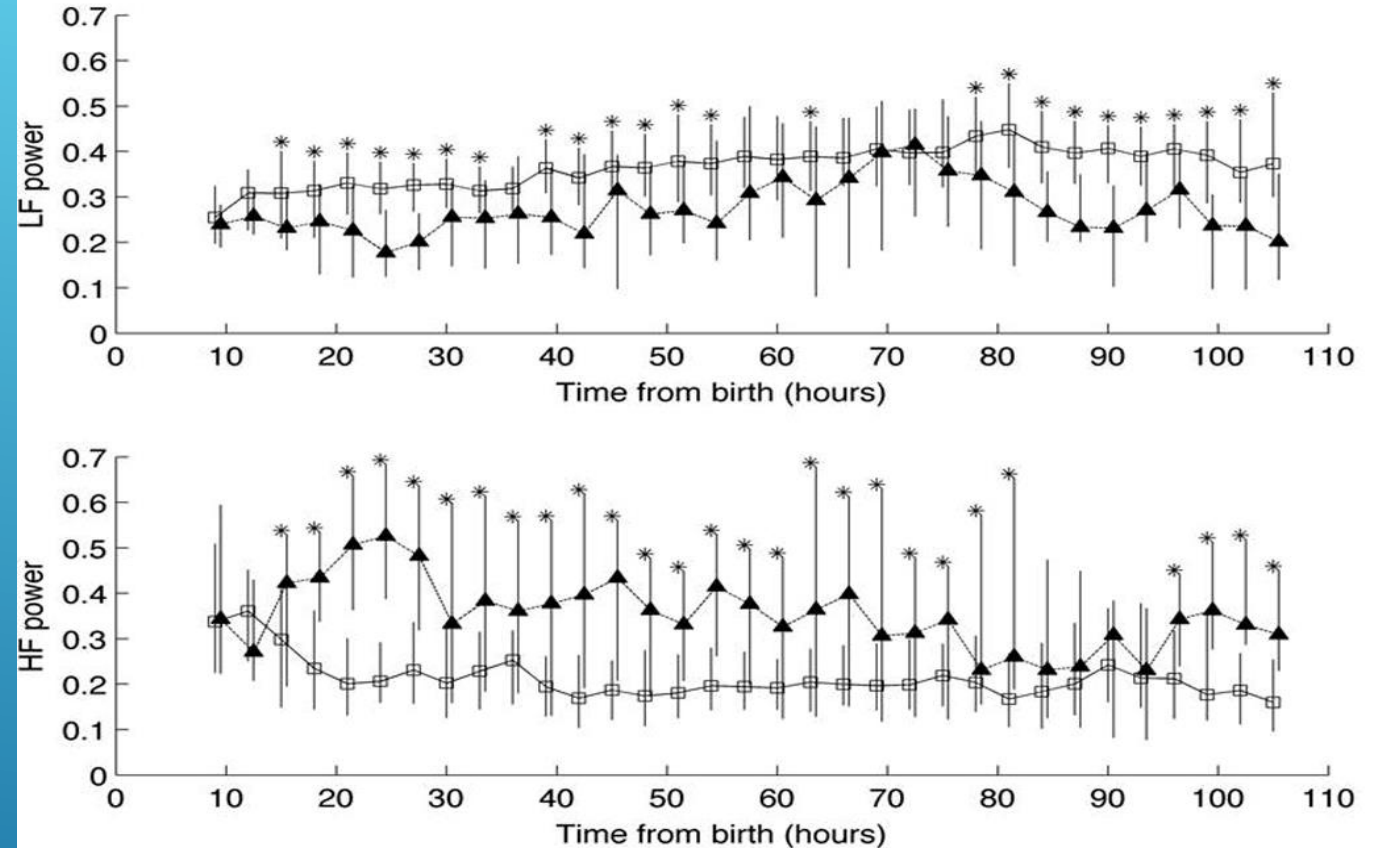
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# PREVIOUS STUDIES

- ▶ 2014 Masaro et al. LF relative power was lower at nearly all time points and HF power was higher at all time points, in infants in the adverse outcome group compared to those with favorable outcome.
- ▶ Particularly salient at 24 hours

Time	9	12	15	18	21	24	27	30	33	36	39	42	45	48	51	54	57	60	63	66	69	72	75	78	81	84	87	90	93	96	99	102	105	
# subjects	4	4	6	7	8	8	9	9	8	8	9	10	10	10	9	10	10	10	10	9	9	9	10	10	9	10	10	7	7	6	5	5	3	□ Normal outcome
# epochs	41	72	93	119	139	143	149	152	141	140	134	162	178	160	157	158	172	178	157	162	160	158	171	158	152	157	145	126	118	98	74	53	40	
# subjects	7	6	6	8	9	9	8	7	7	7	8	8	8	8	7	5	6	6	7	7	6	6	6	6	6	5	7	7	6	6	6	4	3	▲ Adverse outcome
# epochs	100	90	96	115	142	132	121	123	116	105	138	141	134	131	107	78	91	103	105	114	105	104	103	101	96	88	98	123	98	103	63	52	53	



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# PREVIOUS STUDIES

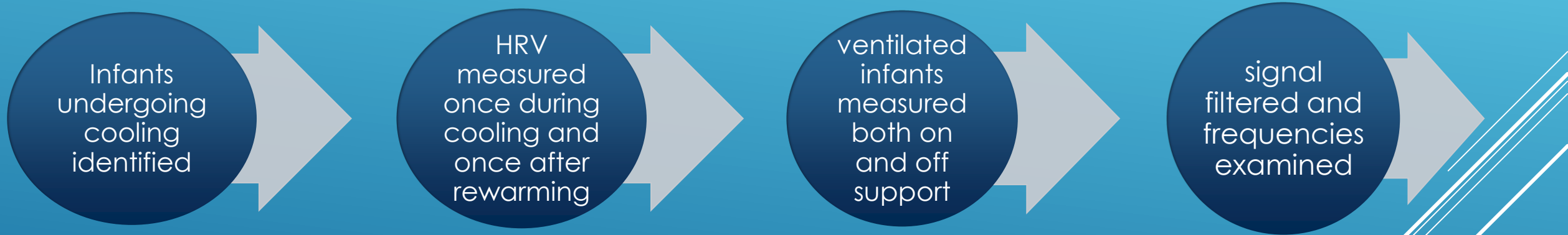
- ▶ 2017 Goulding et al. There is decreased HRV with increasing EEG grade of HIE in both the pre-TH and TH groups and in infants with moderate EEG grades undergoing TH, the HF feature of HRV was increased with a resultant decrease in the LF/HF ratio
- ▶ 2017 Masaro et al. HRV did change as a result of temperature. Demonstrated an overall decrease in variability as infants returned to normothermia.
- ▶ 2017 Metzler et al. A decrease in relative LF power and an increase in relative HF power was observed across brain injury pattern groups there was a significant negative association between brain injury pattern and relative LF power .



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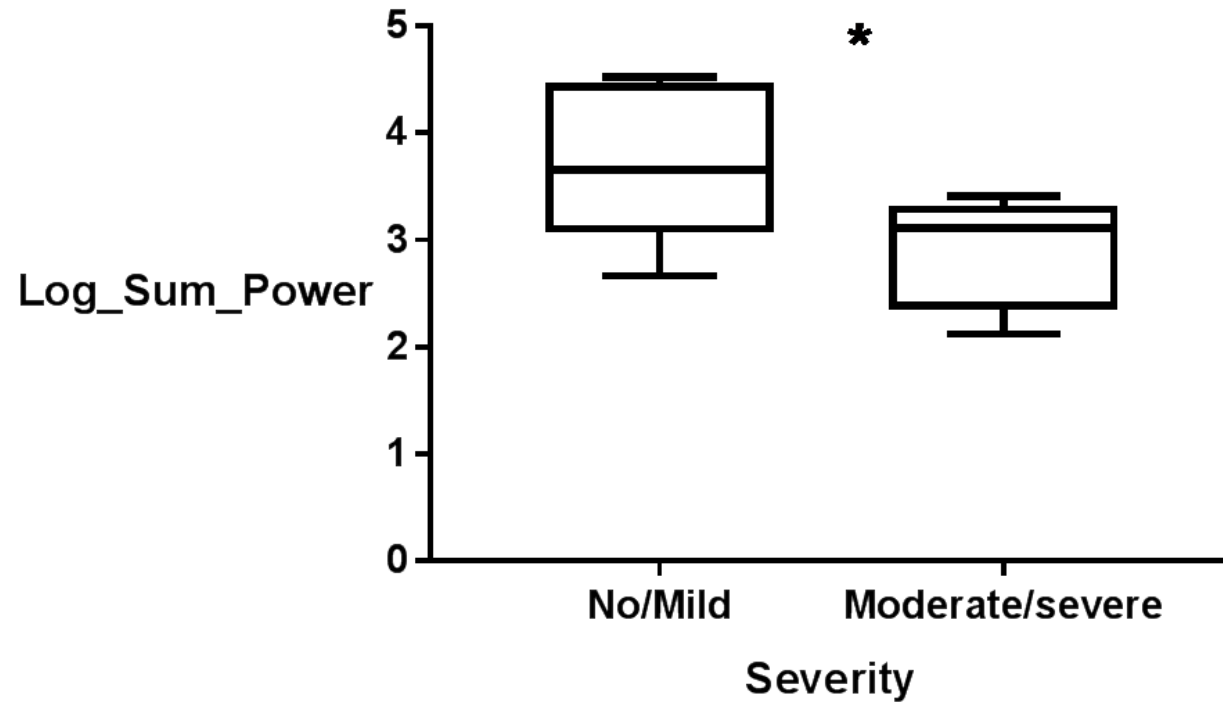
# STUDY DESIGN



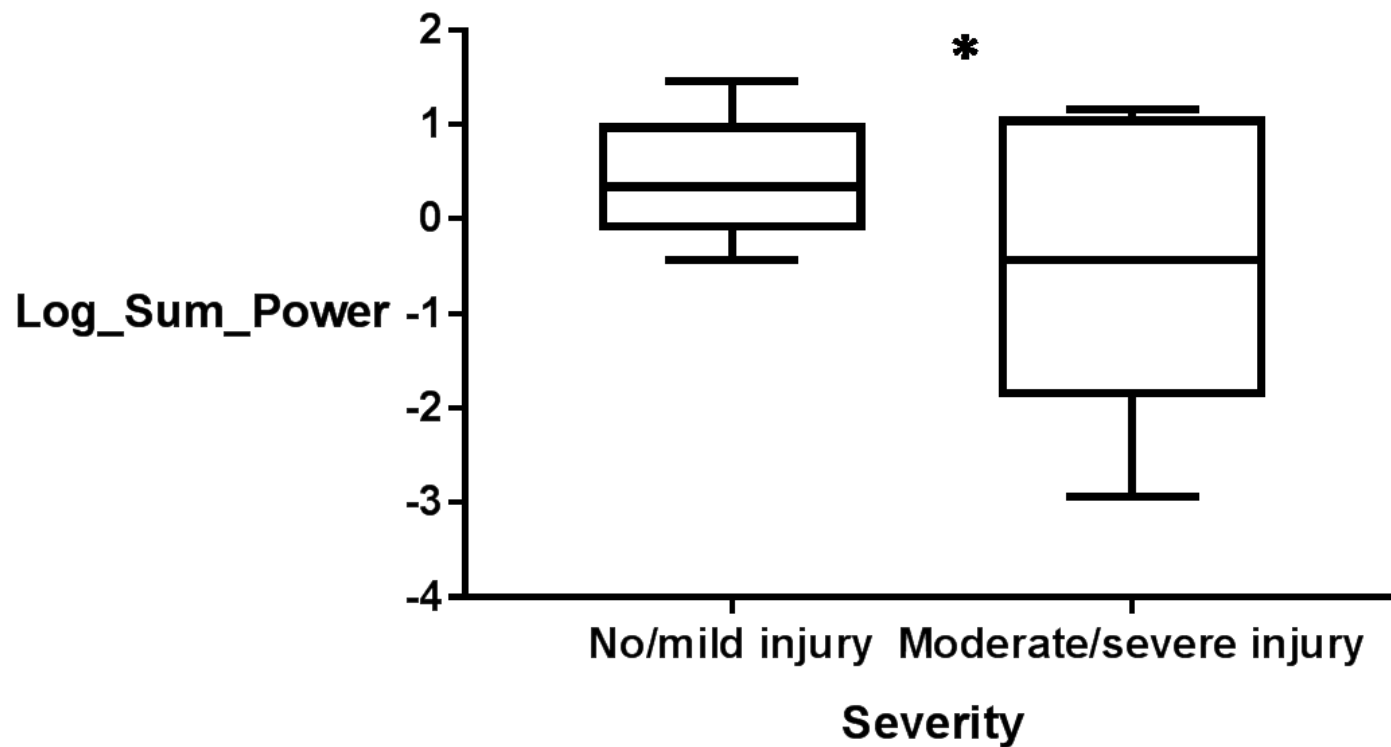
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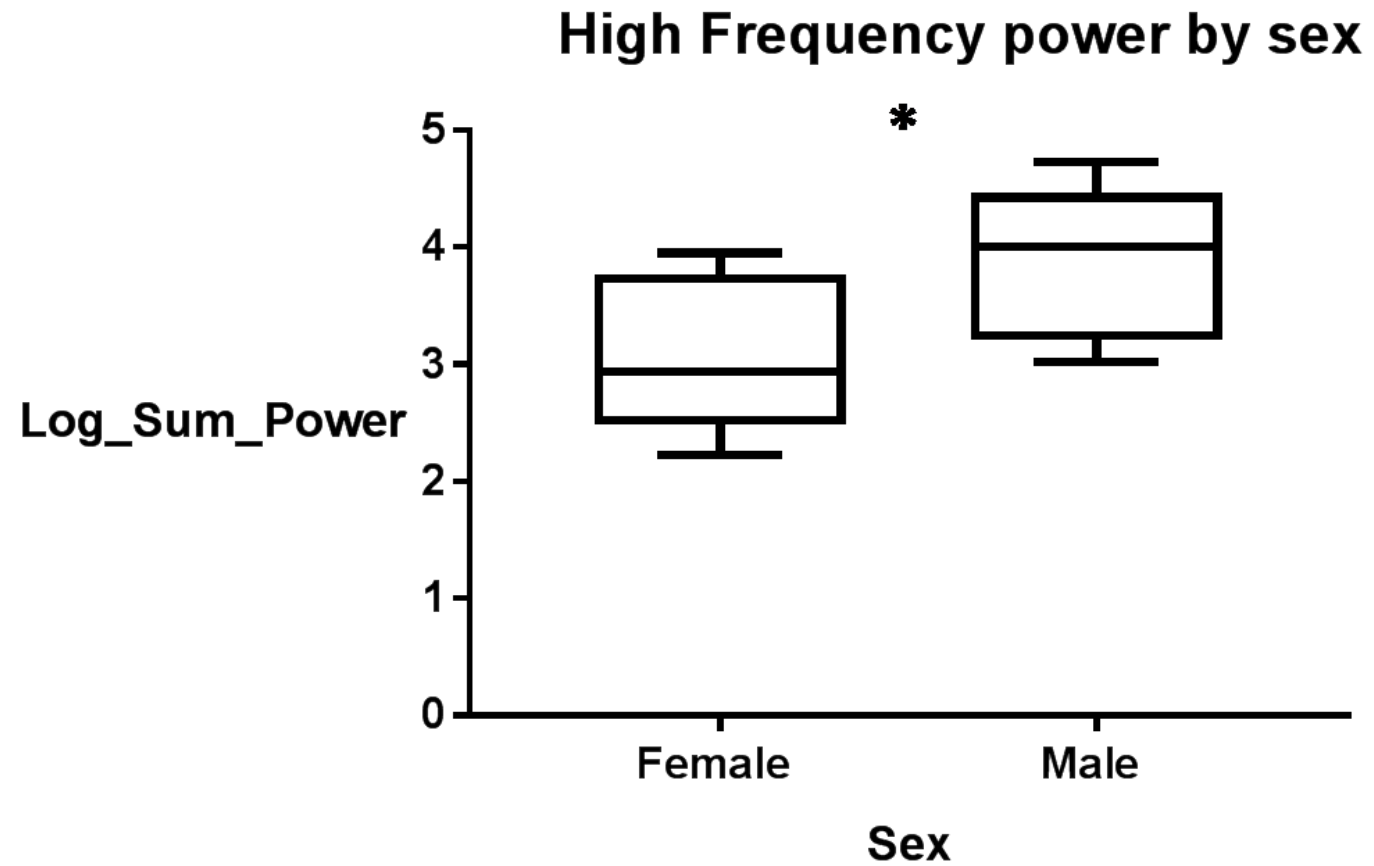
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## Low frequency power during hypothermia by severity

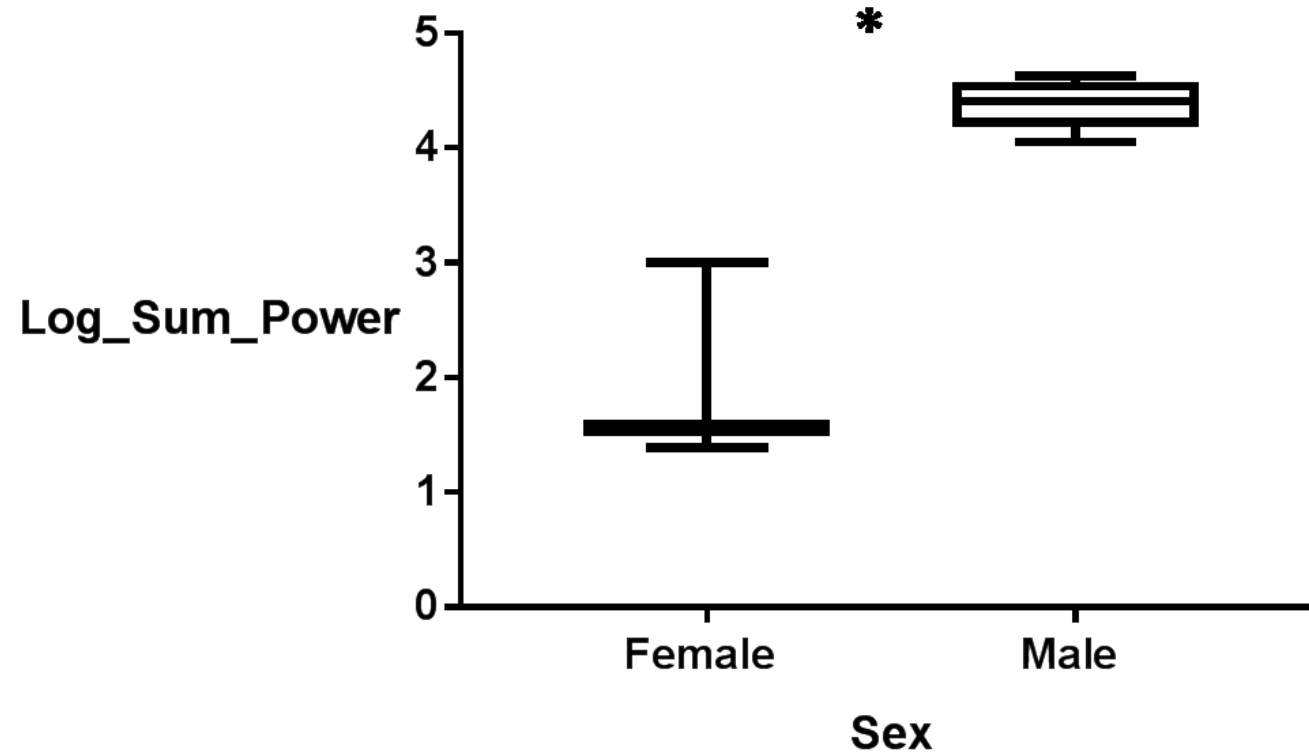


### Ratio of LF/HF power by severity

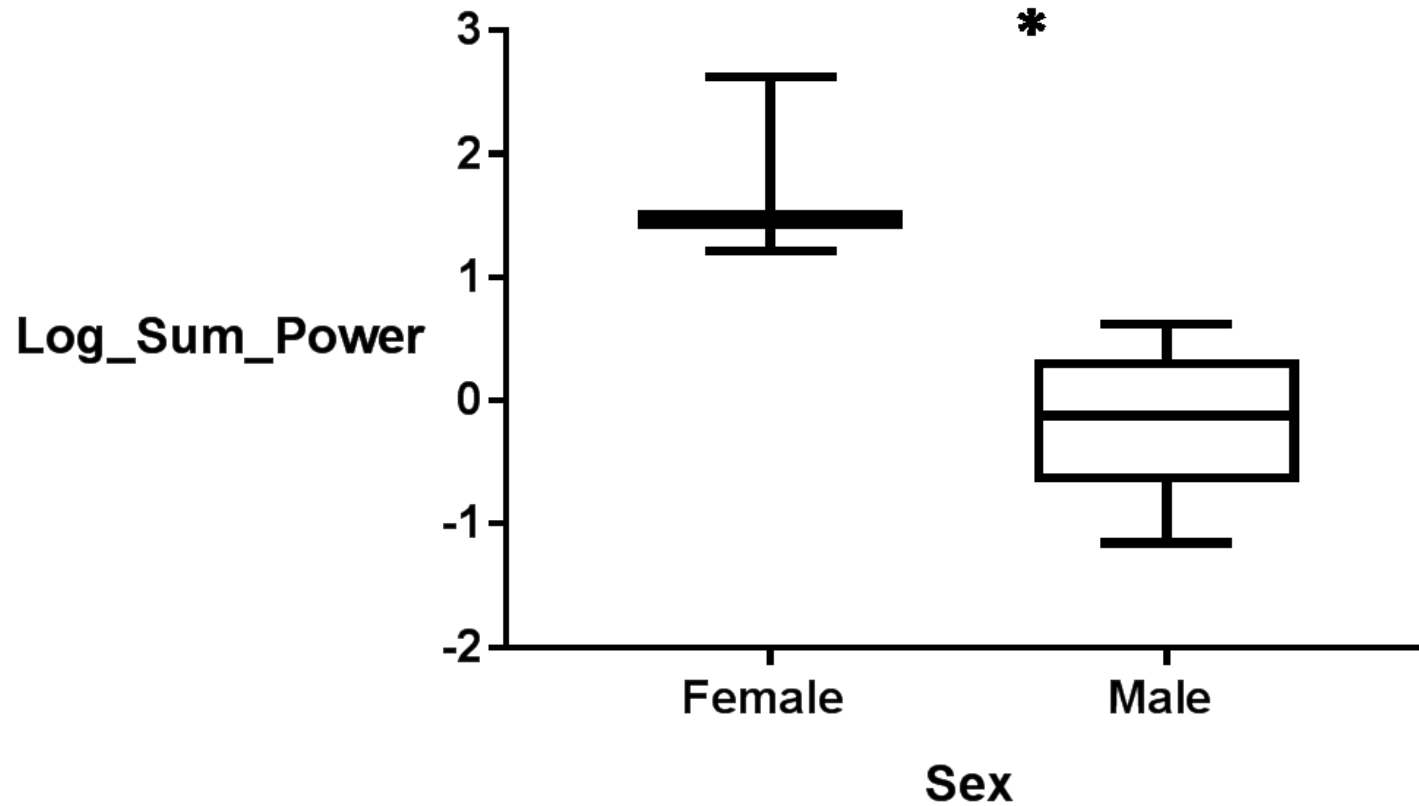




## High frequency power during normothermia by sex

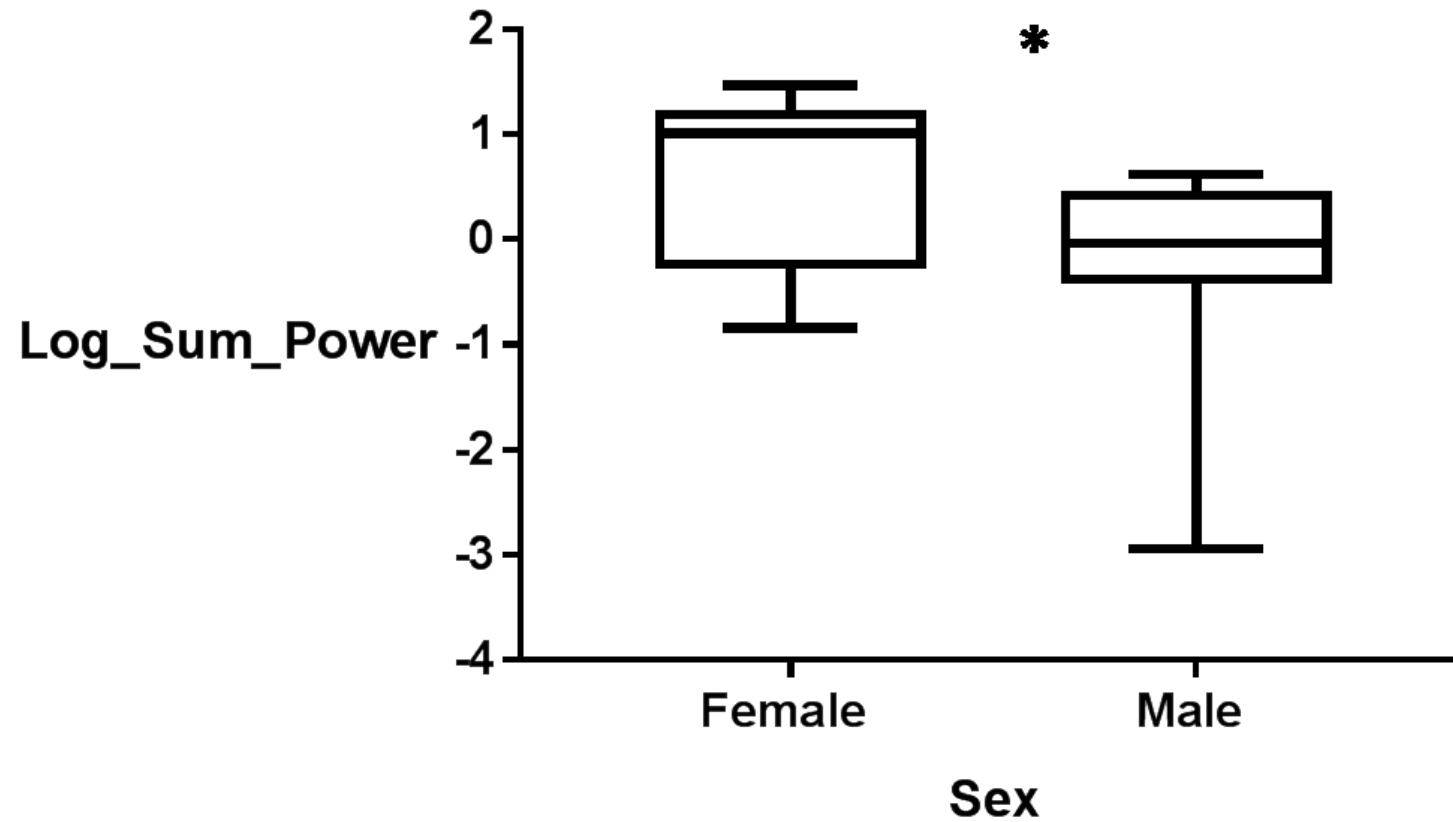


## Ratio of LF/HF power during normothermia by sex





## Ratio of LF/HF power by sex



# HRV KEY POINTS

- ▶ Neonates undergoing hypothermia with worse injury exhibit lower LF power compared to neonates with moderate/severe injury.
- ▶ During therapeutic hypothermia, neither mechanical ventilation or pressor substantively impacted HRV.
- ▶ There are differences in HRV between female and male neonates.
- ▶ Continuous HRV monitoring may provide prognostic value.



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# ACKNOWLEDGEMENTS

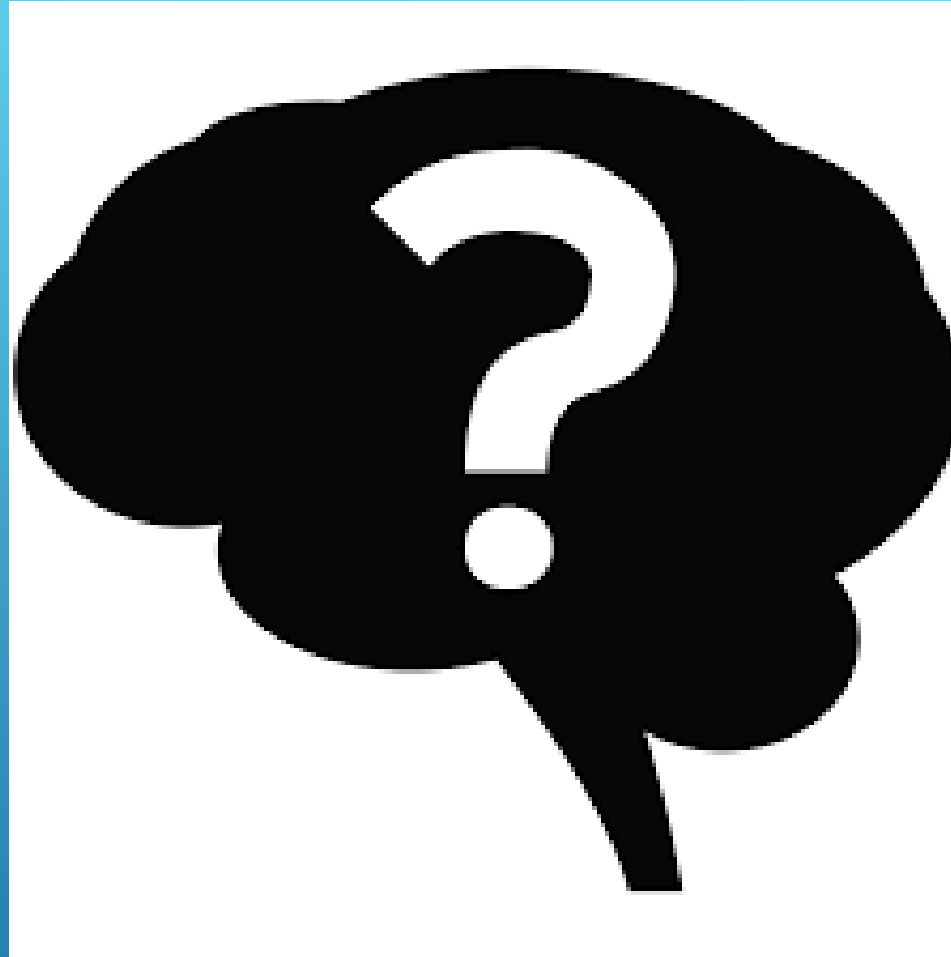
- ▶ Dr. Michael Weiss
- ▶ Drs. Krueger and Weaver
- ▶ Livia Sura
- ▶ FN3 babies and families
- ▶ FN3 hospitals- that's you!



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# QUESTIONS



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