

Evaluation of the Combined Prehospital Hypoxia-Hypotension “Depth-Duration Dose” and Mortality in Major Traumatic Brain Injury

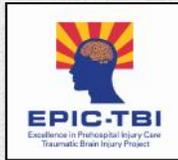
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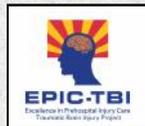
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Disclosure



- This study is funded by the NIH-NINDS
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 **Background** 

- Prehospital hypoxia and hypotension *dramatically* increase mortality in TBI




Background

- This literature is based upon simple dichotomies:
 - Did the patient ever have a hypoxic event?
 - Did the patient ever have a hypotensive event?
- Until recently, nothing was known about the impact of depth or duration of prehospital hypoxia or hypotension




 **Why is So Little Known?** 

- Linkage of detailed EMS data to TC outcomes is challenging →
 - TC-based registries have little or no prehospital data
 - Even those that do have EMS data... typically only have one recorded measurement from the field

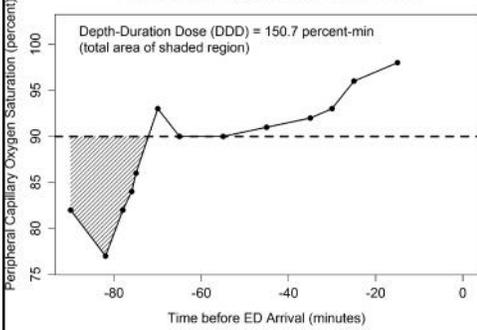


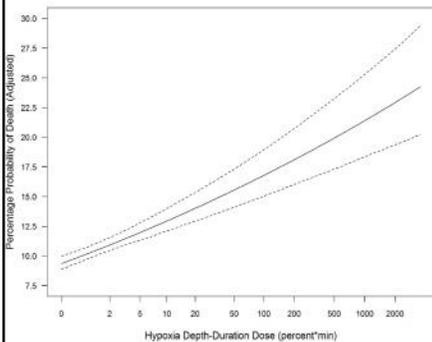

Previous Reports on "Dose"

- EPIC Study Database:
 - Extensive EMS data including *all* recorded BPs...*and* associated *times*...linked to comprehensive trauma center data
- We defined the "Depth-Duration Dose" for hypoxia and for hypotension
 - Reported the separate dose-effects of hypoxia and hypotension



Case Example 2: Hypoxia Depth-Duration Dose

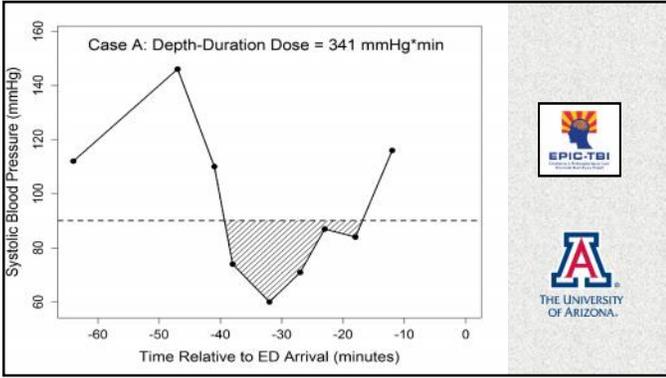


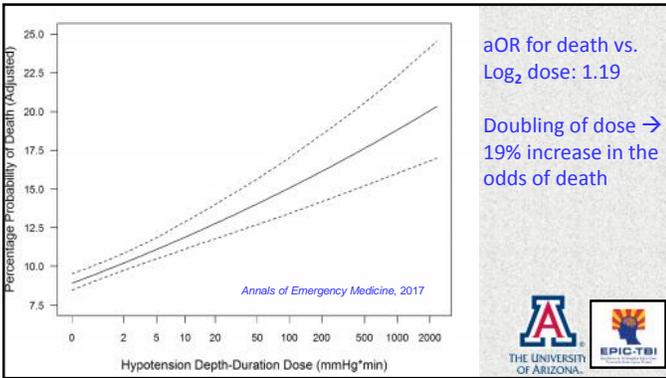


aOR for death vs. Log_2 dose: 1.22

Doubling of dose \rightarrow 22% increase in the odds of death







The Next Logical Step

- Obviously, hypoxia and hypotension are not mutually exclusive
- **Question:** Is there a way to meaningfully evaluate the "combined" dose effects in patients with either hypoxia or hypotension or both?



Approach

- In major TBI, evaluated the association between mortality and the dose of prehospital hypoxia and hypotension



Approach

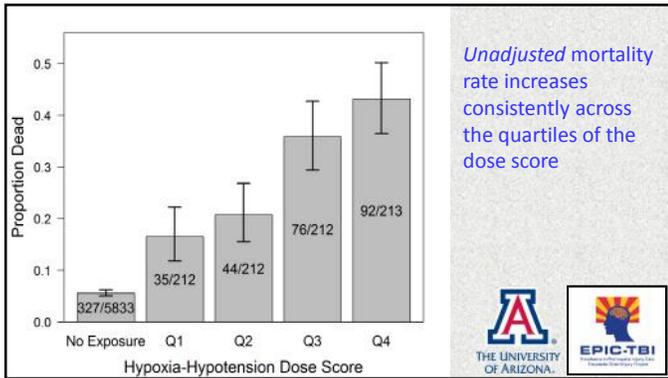
- LR was used to determine the association between odds of death and the doses of hypoxia and hypotension
- A dose "score" was defined by *combining the fitted effects* of both hypoxia and hypotension
- Thus, the model simultaneously accounts for adjusted death risk for patients with *either* hypoxia *or* hypotension *or* both

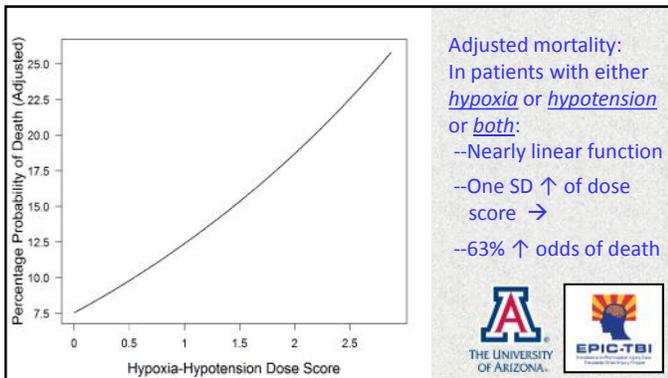


Results

- Pre-implementation cohort: 16,711
 - 8469 met inclusion criteria
- 6682 (78.9%) had at least two EMS SBPs and SpO₂s with recorded times
 - Hypoxia only: 418
 - Hypotension only: 319
 - Both: 112





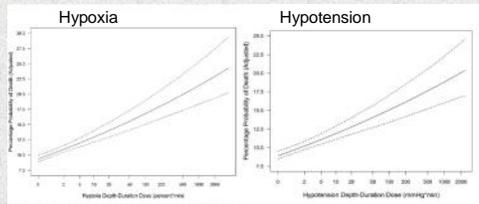


Limitations

- ▶ Observational
- ▶ Association doesn't prove cause
- ▶ Does not prove that treating hypoxia or hypotension improves outcome
 - ▶ One of the main study hypotheses

Discussion

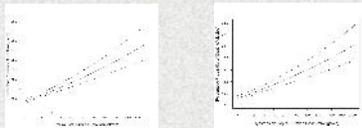
- ▶ The separate models for dose revealed remarkably similar patterns



- ▶ So...at the cellular level...is this just two ways of looking at the same issue?

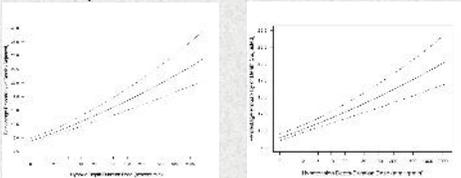
What About Combined Effects?

- For both hypoxia and hypotension...at the cellular level...the primary physiological insult is inadequate oxygen delivery
- Some have hypothesized that the combined effect of hypoxia and hypotension would not add significantly to the individual effect...since they "look similar" at the cellular level



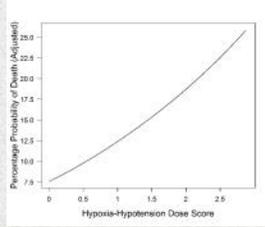
What About Combined Effects?

- Does this mean that the addition of one to the other will have little or no effect since the neuron is already experiencing oxygen deprivation regardless of which physiological insult is present?



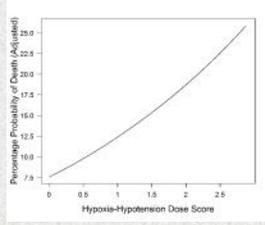
Conclusions

- ▶ Our findings provide strong evidence that hypoxia and hypotension depth/duration have an additive effect on TBI mortality
- ▶ The findings also show that the effects of hypoxia and hypotension are far more complex than is inferred by the current “dichotomous” literature



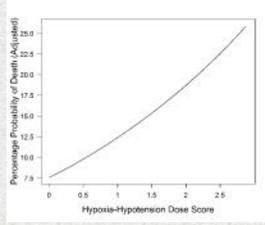
Conclusions

- ▶ The combined “dose” of hypoxia and hypotension is strongly...and essentially linearly...associated with mortality
- ▶ This model allows “co-mingling” of hypoxia and hypotension doses both separately, and in combination



Conclusions

- ▶ Summary:
 - ▶ Given all of the issues that impact survival...it's remarkable how dramatically these two factors...occurring in the field...influence final outcomes in TBI



Future Considerations

- ▶ We plan to use the post-implementation cohort from EPIC as a dataset for validating and optimizing the model

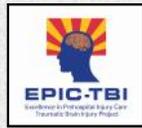




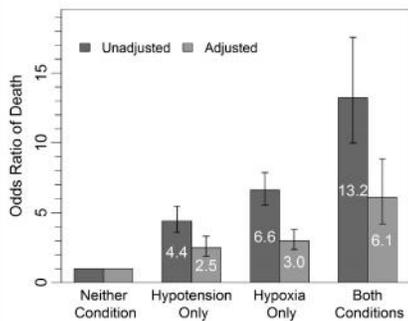
Special thanks to the EPIC Partners



Arizona Fire Departments and EMS Agencies



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Unadjusted and adjusted ORs for death for hypoxia or hypotension or both:

Future Considerations

- ▶ Does this have future clinical implications?
- ▶ Calculation of hypoxia dosage requires real-time computer support
- ▶ These findings point to the potential need for monitors that can calculate the dose in real-time and potentially help with clinical decision support



Methods: Patients



- Inclusion:
 - Major TBI: CDC Barell Matrix Type 1
 - 1/2007-3/2014
 - Pre-implementation cohort
 - SBPs: 200mmHg
 - Age 10



The Excellence in Prehospital Injury Care (EPIC) Study

- ▶ Statewide, 9-year, before-after system evaluation of the impact of implementing the National EMS TBI Guidelines throughout Arizona
- ▶ 125 agencies and the 8 level I trauma centers participating
- ▶ Will enroll over 22,000 major TBI patients