

Predicting Hypotensive Episodes  
in the  
Traumatic Brain Injury Domain  
Thesis Summary

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# Introduction

- What is the problem?
- Background
- Results
- Summary

# What is the problem?

- Q: Can statistical models predict hypotensive episodes in a TBI ICU?
  - Hypotension = dangerously low blood pressure
  - TBI = Traumatic Brain Injury
  - ICU = Intensive Care Unit
- A: Yes, see AvertIT 2008 - 2011
  - Using BANN model
  - BANN = Bayesian Artificial Neural Network
  - Very complex “Black Box” model

# Can a simpler model be used?

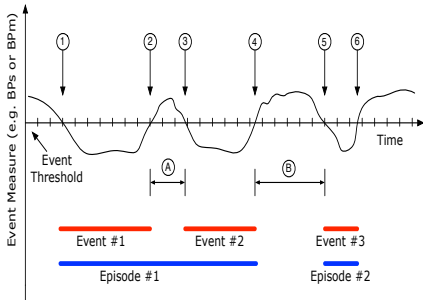
- Q: Can simple statistical models predict hypotensive episodes in a TBI ICU?
- A: Yes, my thesis shows logistic regression models can also predict hypotensive episodes in a TBI ICU

# Secondary Insults

- Complications that occur *after* a patient has been stabilised
  - Systemic, Hypotension
  - Intracranial, Raised Intracranial Pressure (ICP)
- Edinburgh University Secondary Insult Grades (EUSIG) — Jones et al. 1994

See Chapter 2, page 7, for details

# Hypotensive Episodes



- EUSIG defines event
- Close events are episodes
- Episode starts are of interest

See Chapter 2, page 12, for details

# Simple and Complex Models

- Simple
  - Logistic Regression
- More complex
  - Penalised Logistic Regression
- Much more complex
  - Bayesian Artificial Neural Network

See Chapter 3, page 48, for details of logistic regression models

See Chapter 3, page 56, for details of neural network models

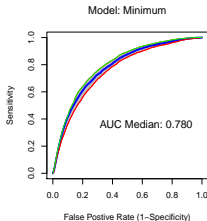
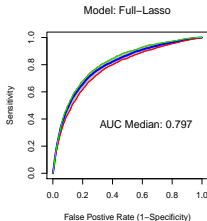
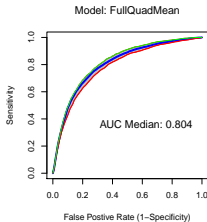
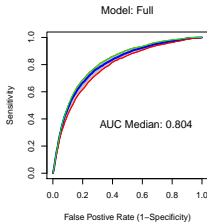
# Simple Models

- Logistic Regression
- Full variables — HRT, BPs, BPd, BPm
- Minimum variables — HRT, BPm
- Stats based preprocessing
- Best AUC — 0.80

See Chapter 5, page 127, for details



# Stats Based LR Models



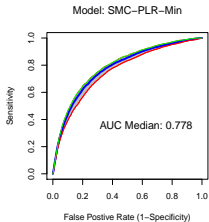
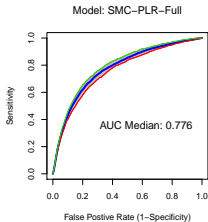
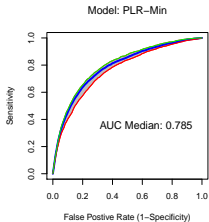
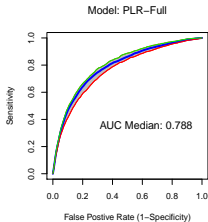
- ROC across 50 test sets
- Best Model, Full
- Best AUC, 0.80, SD 0.01
- Stats based preprocessing
- 30 minute data buffer

# More Complex Models

- Penalised Logistic Regression
- Every minute of a 30 minute data buffer
- Full and Minimum variables
- Best AUC — 0.79

See Chapter 5, page 101, for details

# PLR Models



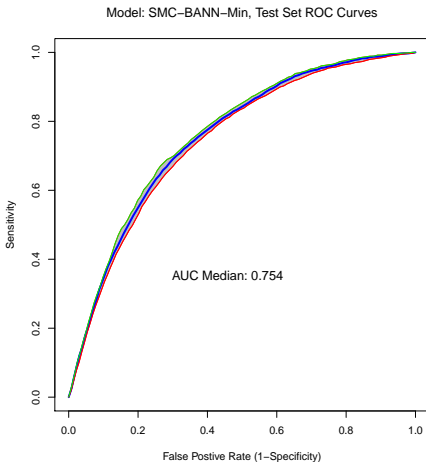
- ROC across 50 test sets
- Best Model, PLR-Full
- Best AUC, 0.79, SD 0.01
- Each minute as inputs
- 30 minute data buffer
  
- More complex but less performance

# Much More Complex Models

- Bayesian Artificial Neural Network
- Every minute of a 30 minute data buffer
- Full and Minimum variables
- Best AUC — 0.74

See Chapter 6, page 153, for details

# BANN Model



- ROC across 5 test sets
- Each test set 1000 nets
- Best Model, SMC-BANN-Min
- Best AUC, 0.75
- Minimal Inputs, HRT and BPM
- Each minute as inputs
- 30 minute data buffer
  
- Much more complex but even less performance

# Summary

- Logistic Regression Models
  - Simple outperforms complex
  - Stats based preprocessing
  - Full variables — AUC 0.80
  - Minimal variables — AUC 0.78
  - Refs: Jones 1994, Stell 2012, Donald 2012

# References

- Donald et al.(2012) Rob Donald, Tim Howells, Ian Piper, I. Chambers, G. Citerio, P. Enblad, B. Gregson, K. Kiening, J. Mattern, P. Nilsson, A. Ragauskas, Juan Sahuquillo, R. Sinnott, and A. Stell. Early warning of EUSIG-defined hypotensive events using a bayesian artificial neural network. In Martin U. Schuhmann and Marek Czosnyka, editors, *Intracranial Pressure and Brain Monitoring XIV*, volume 114 of *Acta Neurochirurgica Supplementum*, pages 39–44. Springer Vienna, 2012.
- Jones et al.(1994) Patricia Jones, Peter Andrews, Susan Midgley, Shirley Anderson, Ian Piper, Janis Tocher, Alma Housley, Jane Corrie, James Slattery, Mark Dearden, and Douglas Miller. Measuring the burden of secondary insults in head-injured patients during intensive care. *Journal of Neurosurgical Anesthesiology*, 6:4–14, 1994.
- Stell et al.(2012) Anthony Stell, Richard Sinnott, Rob Donald, and Ian Piper. Supporting clinical trials to predict adverse events in the brain trauma domain. In *The 25th IEEE International Symposium on Computer-Based Medical Systems (CBMS 2012)*, 2012.