

Early Warning of EUSIG Defined Hypotensive Events Using a Bayesian Artificial Neural Network

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On behalf of the BrainIT Consortium



Conflict of Interest Disclosure

- Rob Donald — shareholder in C3 Global Ltd
- All other authors — no conflict of interest



Secondary Insults

- Miller et al, early 1980s
- Jones et al, 1994
 - Edinburgh University Secondary Insult Grading (EUSIG)
 - BPs ≤ 90 , BPm ≤ 70 , 5 min holddown
 - Hypotension related to outcome
 - Hypotension *not* just a TBI problem

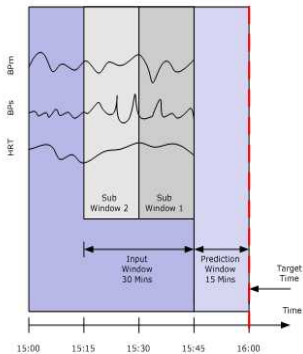


Machine Learning

- Classification Technique
- Bayesian Artificial Neural Network



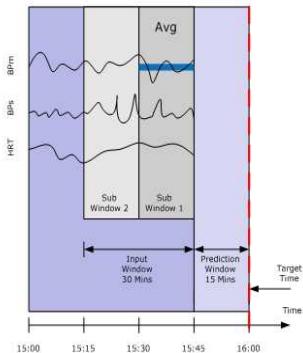
Data Preparation



- Input signals
- Sub Windows
- Summary Statistics



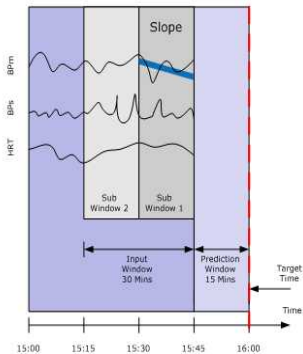
Data Preparation



- Input signals
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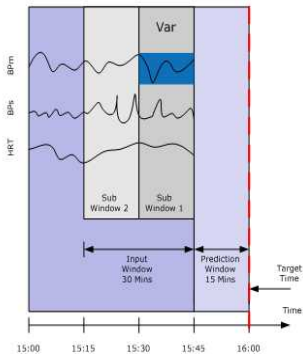
Data Preparation



- Input signals
- Sub Windows
- **Summary Statistics**



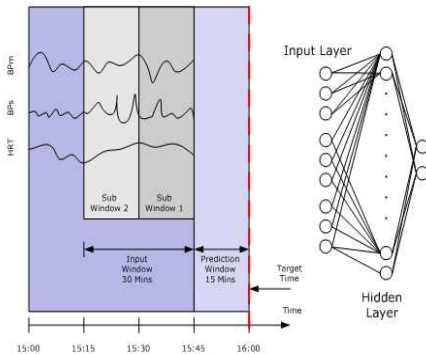
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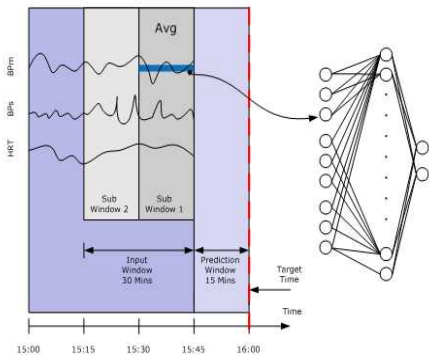
BANN Training



- Neural Network
- Input Connections



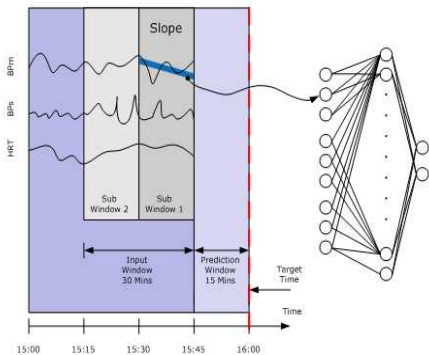
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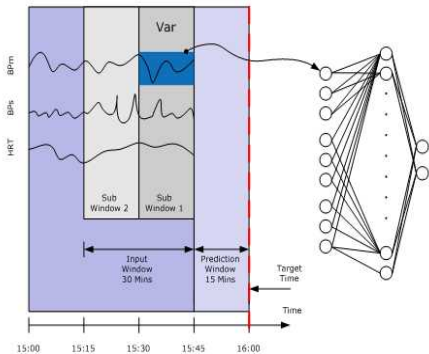
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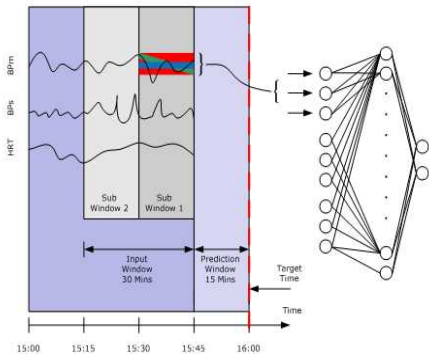
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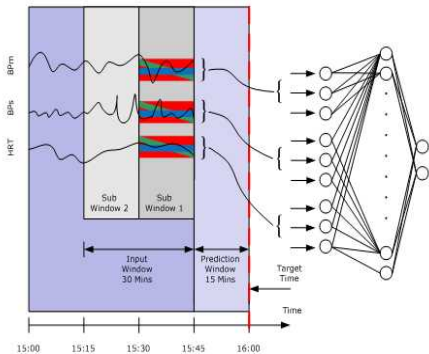
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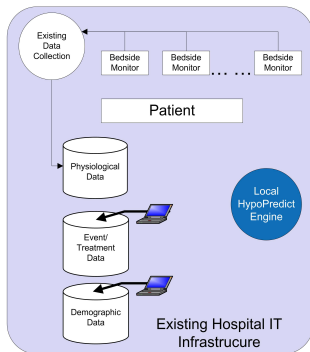
BANN Training



- Neural Network
- Input Connections



Phase I Trial



- Local Hospital
- BrainIT Hospitals
- Central Datastore NeSC Glasgow



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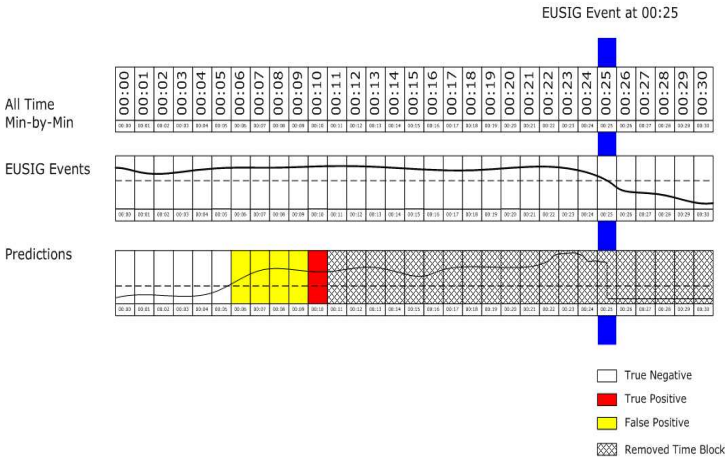


Phase II Trial

- 2 Step Sequential Clinical Trial
- Simon 1989; Hanfelt et al. 1999
- Stage 1, 13; Stage 2; 46
- Targets, Sensitivity > 30%, Specificity > 90%

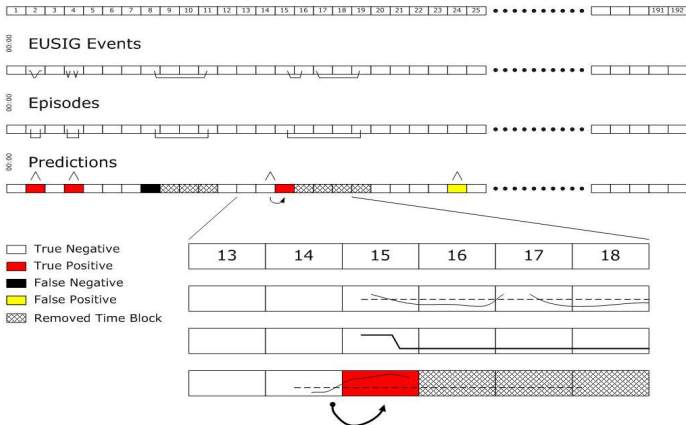


Model Selection



Block Technique

All Time (30 min Blocks)

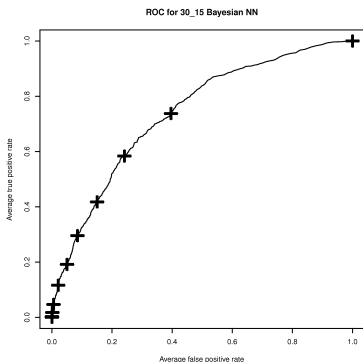


Phase I - Results So Far

Age	Sex	Sens NoChks	Spec NoChks	FPos	Sens withChks	Spec withChks	FPos
27	M	100.00%	95.26%	22	100.00%	96.77%	15
38	M	18.75%	99.09%	3	18.75%	99.70%	1
16	M	66.67%	81.43%	52	55.56%	84.64%	43
35	F	60.00%	75.08%	165	60.00%	77.79%	147
46	M	14.29%	94.69%	6	14.29%	96.46%	4
29	M	70.00%	90.86%	16	70.00%	93.14%	12
35	F	0.00%	84.36%	61	0.00%	86.92%	51
41	M	28.57%	91.97%	57	28.57%	93.38%	47
57	M	56.25%	91.59%	54	59.38%	95.79%	27
66	M	33.33%	96.36%	6	33.33%	97.58%	4
74	F	40.00%	57.50%	35	40.00%	62.50%	30
19	M	79.17%	55.23%	274	70.83%	60.29%	243
25	M	60.00%	81.69%	26	40.00%	82.39%	25
38	M	43.75%	88.00%	57	43.75%	94.11%	28
74	F	64.86%	55.23%	154	56.76%	62.21%	130
64	M	33.33%	96.96%	29	16.67%	98.01%	19
21	M	83.33%	61.97%	54	83.33%	66.90%	47
59	M	24.62%	90.78%	81	27.69%	96.81%	28
52	M	0.00%	81.82%	20	0.00%	85.45%	16
27	M	0.00%	94.35%	10	0.00%	98.31%	3



Phase I — Model Assessment



- Initial assessment from 20 patients
 - Sensitivity 41% S.E. 6%
 - False Positives (raw) 17% S.E. 3%
 - False Positives (suppression techniques) 14% S.E. 3%
 - Average Early Warning 21 mins S.E. 0.74



Summary

- BANN Designed and Trained
- Part of a Prediction Engine
- Phase I — Sensitivity Good, Work On False Positives
- Phase II — Starting Soon



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Thanks for your time

