

How sick is this child?

Predicting serious infection using four vital signs

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Introduction

Vital signs can predict serious illness in children, but measuring them accurately and interpreting their values is difficult in primary and emergency care.

Combining vital signs to produce a simple score may be a more useful and practical way of identifying children with serious illness.

Methods

Dataset: Observations on 568 children admitted to a paediatric assessment unit.

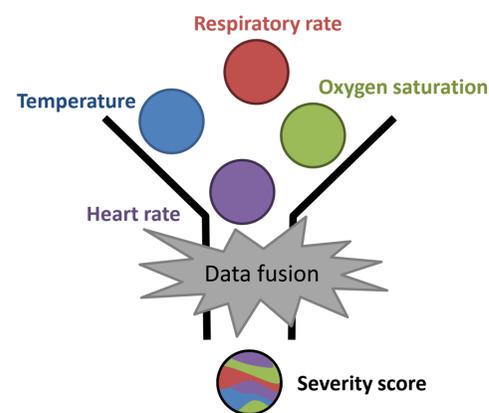
Variables: heart rate, respiratory rate, oxygen saturation, and temperature.

Outcome: diagnosis of serious infection (directly life-threatening, or with high chance of life-threatening complications).

Various methods for predicting serious infection from the vital signs were investigated:

- Linear regression
- Logistic regression
- Gaussian mixture model (GMM) classifier
- Parzen windows novelty detector
- Subset of existing scoring system (PAWS)

Estimates of model quality were obtained using jack-knifing.



Results

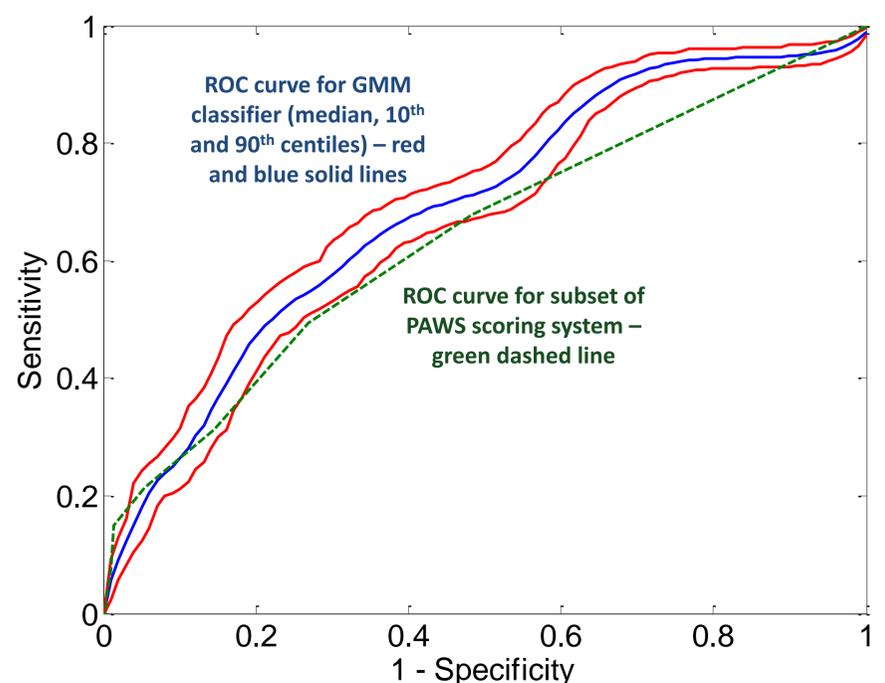
Both regression and probability density methods performed better than the PAWS subset. This had a potential range of 0-12 points, with best separation achieved when a score ≥ 2 was used to identify serious infection.

The best performing method was a Gaussian mixture model classifier, which fits a 4-dimensional Gaussian (normal) distribution to the vital signs from each group. The probability of a child belonging to each group is then calculated.

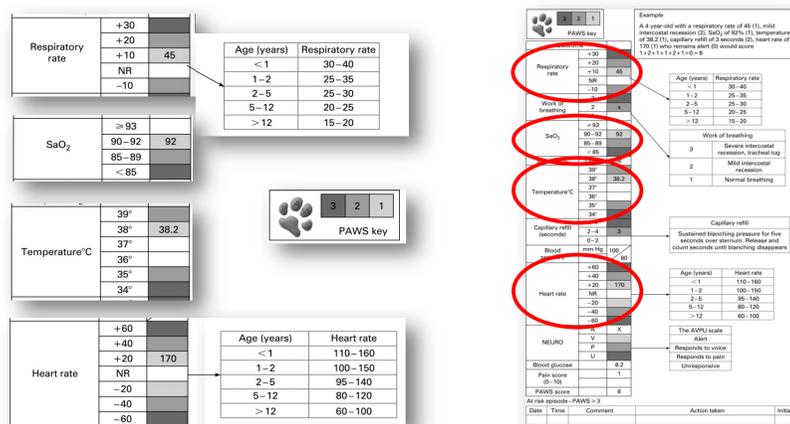
Results of prediction using different methods

Method	Area under ROC	Sensitivity (%)	Specificity (%)
Linear regression	0.665 (0.64-0.69)	63.4 (58-68)	60.6 (57-68)
Logistic regression	0.668 (0.65-0.69)	62.0 (57-67)	63.6 (58-68)
GMM classifier	0.685 (0.66-0.72)	64.6 (61-68)	65.7 (62-70)
Parzen windows	0.681 (0.65-0.71)	64.7 (61-69)	67.7 (65-72)
PAWS subset	0.641	73.1	49.5

For all methods except the PAWS subset, values are shown as the mean (10th-90th centile) results from multiple jack-knifing runs.



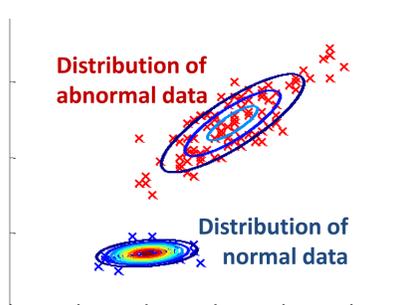
Subset of existing PAWS system



From Egdell et al. Emerg Med J 2008;25:745-749

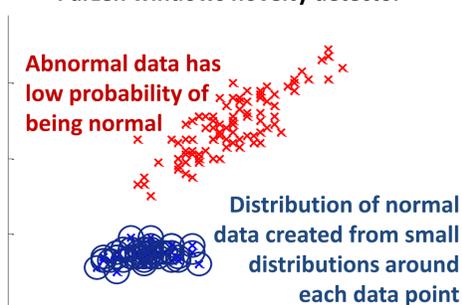
Data fusion methods based on probability density

Gaussian mixture model classifier



Data classified based on probability of belonging to each group.

Parzen windows novelty detector



Data with low probability is 'novel' compared to the known normal data

Conclusions

The presence of serious infection in children can be predicted with moderate accuracy using four vital signs. Data fusion using a GMM classifier outperforms an existing additive scoring system.

Although the score cannot be calculated by hand, it could be incorporated into an integrated monitoring device, or provided as an 'app' on a mobile phone.

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