Supplemental file 1

# Overview of the HPI algorithm derivation.

Full details on the derivation of the HPI algorithm are described in Hatib F, Jian Z, Buddi S, Lee C, Settels J, Sibert K, Rinehart J, Cannesson M.Machine-learning Algorithm to Predict Hypotension Based on High-fidelity Arterial Pressure Waveform Analysis. Anesthesiology 2018.

The hypotension prediction index is derived from features the arterial waveform sampled at 100Hz which are the processed through the Edwards FloTrac algorithm (FloTrac, Edwards Lifesciences, Irvine , CA). The FloTrac algorithm performs the arterial pressure waveform signal preprocessing, heart-beat detection, dicrotic notch detection, and removal of artifacts from the processed arterial pressure waveform data.

Briefly from the arterial waveform a number of different sources of information are gathered.

1. Core hemodynamic variables were calculated through the FloTracTM and COTrekTM hemodynamic algorithms. These algorithms computed the core hemodynamic variables including - CO, SV, SVR, PR, Arterial tone, Windkessel Compliance, Peripheral Resistance, SVV, PPV, MAP, SYS, DIA.
2. An expanded set of hemodynamic variables based on different phases of the arterial waveform were then calculated to obtain additional information of preload, contractitliy and afterload including arterial slopes, amplitude and AUC of different arterial phased that correspond parameters such as large vessel compliance, stroke volume and afterload amongst others. In total of 166 basic hemodynamic variables extracted from the arterial pressure waveform.
3. The complexity and variability the 166 features were the computed using sample and approximate entropy leading to a total of 3,022 waveform features.
4. Features under went ROC analysis and those with an AUC of greater than 0.85 were selected out leaving 51 features. Combinations of these between one and three

of these variables at power levels of -2 to +2 were generated to assess the non linearity of these relationship between the waveform derived features. This generated 2.6 million features in total.

1. The 2.6 million features were then subject to machine learning techniques using logistic regression analysis. Features were retained where the area under the curve was greater than 0.8 for positive and negative data segments of the training data set; and when sequential forward features were selected with logistic regression. Positive segments were defined as a section of data where MAP <65mmHg for graeter than 1 minute and a negative section the midpoint of a 30-min continuous section of data points, 20min away from any hypotensive event, where all data points in that section showed a MAP > 75 mmHg
2. Overall 23 features were selected out that are predictive of future hypotension which comprise the basis of the HPI algorithm

Additional analysis of HPI and incidence and time to hypotension

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **HPI** | **Event Rate [95% CI], %** | **Median Time to Event [95% CI], min** | **25th% Time to Event (min) [95% CI], min** | **75th% Time to Event [95% CI], min** | **10th% Time to Event (min) [95% CI], min** | **90th% Time to Event [95% CI], min** | **# of samples** |
| 0-50 | 34.3 [34, 34.6] | 8.02 [7.99,  8.04] | 4.14 [4.11,  4.17] | 12.91 [12.88,  12.94] | 1.95 [1.93,  1.97] | 16.92 [16.91,  16.94] | 45718/133872 |
| 51-99 | 74.9 [74.6,  75.3] | 3.21 [3.18,  3.24] | 0.94 [0.93,  0.96] | 7.72 [7.67,  7.77] | 0.03 [0.02,  0.04] | 13.51 [13.45,  13.56] | 93418/125016 |
| 100 | 100 [100, 100] | 0 [0, 0] | 0 [0, 0] | 0 [0, 0] | 0 [0, 0] | 0 [0, 0] | 32456/32456 |
|  |  |  |  |  |  |  |  |
| 0-60 | 37.2 [36.9,  37.6] | 7.56 [7.52, 7.6] | 3.75 [3.72,  3.78] | 12.64 [12.6,  12.67] | 1.61 [1.58,  1.63] | 16.73 [16.71,  16.75] | 56535/152378 |
| 61-99 | 78.6 [78.3,  78.9] | 2.95 [2.93,  2.98] | 0.84 [0.82,  0.86] | 7.3 [7.25, 7.35] | 0 [0, 0.01] | 12.95 [12.89,  13] | 84074/107183 |
| 100 | 100 [100, 100] | 0 [0, 0] | 0 [0, 0] | 0 [0, 0] | 0 [0, 0] | 0 [0, 0] | 32883/32883 |
|  |  |  |  |  |  |  |  |
| 0-70 | 40.0 [39.7,  40.4] | 7.12 [7.09,  7.15] | 3.31 [3.28,  3.34] | 12.25 [12.21,  12.28] | 1.28 [1.26,  1.31] | 16.55 [16.52,  16.57] | 67640/169507 |
| 71-99 | 81.2 [80.9,  81.4] | 2.71 [2.69,  2.73] | 0.75 [0.74,  0.77] | 6.94 [6.9, 6.99] | 0 [0, 0] | 12.51 [12.46,  12.57] | 71994/88809 |

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| 100 | 100 [100, 100] | 0 [0, 0] | 0 [0, 0] | 0 [0, 0] | 0 [0, 0] | 0 [0, 0] | 32216/32216 |
|  |  |  |  |  |  |  |  |
| 0-80 | 42.4 [42.1,  42.7] | 6.74 [6.7, 6.77] | 2.97 [2.94, 3] | 11.92 [11.88,  11.95] | 1.06 [1.04,  1.08] | 16.32 [16.3,  16.35] | 78102/184646 |
| 81-99 | 83.6 [83.4,  83.8] | 2.49 [2.46,  2.51] | 0.7 [0.7, 0.7] | 6.56 [6.52,  6.61] | 0 [0, 0] | 12.07 [12.01,  12.12] | 61366/73449 |
| 100 | 100 [100, 100] | 0 [0, 0] | 0 [0, 0] | 0 [0, 0] | 0 [0, 0] | 0 [0, 0] | 32201/32201 |
|  |  |  |  |  |  |  |  |
| 0-85 | 43.4 [43.1,  43.7] | 6.57 [6.53,  6.61] | 2.87 [2.85, 2.9] | 11.75 [11.72,  11.79] | 0.98 [0.96, 1] | 16.25 [16.22,  16.27] | 82997/191602 |
| 86-99 | 84.8 [84.6,  85.0] | 2.38 [2.36,  2.41] | 0.68 [0.67,  0.69] | 6.24 [6.2, 6.28] | 0 [0, 0] | 11.84 [11.78,  11.9] | 57799/68250 |
| 100 | 100 [100, 100] | 0 [0, 0] | 0 [0, 0] | 0 [0, 0] | 0 [0, 0] | 0 [0, 0] | 32877/32877 |