**Creation of a Robust and Generalizable Machine Learning Classifier for Patient Ventilator Asynchrony**

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# **Online Supplement**

**Reproduction:**

Reproduction of our experiment can be performed using our code found at:

<https://github.com/hahnicity/ucdpv_pva_ml>

Reproduction will require our dataset as well. Please contact JYA for access to the dataset at jyadams@ucdavis.edu.

**Supplemental Tables/Figures**

**Table S1**: List of all metadata variables along with a description. These variables were all processed from raw ventilator waveform data and were evaluated as independent features to add to our PVA detection model.

|  |  |  |
| --- | --- | --- |
| Variable Name | Units | Description |
| TVi | Milliliters/second | inspiratory tidal volume, defined as the integral of the flow-time curve values from breath start (BS) to point where flow crosses 0 (x0). |
| TVe | Milliliters/second | expiratory tidal volume, defined as the integral of the flow-time curve values from x0 to breath end (BE) |
| TVe/TVi | Unitless | the ratio of expiratory tidal volume to inspiratory tidal volume |
| I-time | Seconds | the time from BS to [x0 minus 1 time point] |
| E-time | Seconds | the time from x0 to BE |
| I:E ratio | Unitless | the ratio of the I-time to the E-time |
| RR | Unitless | instantaneous respiratory rate, defined as 60/breath time |
| PIF | Liters/minute | peak inspiratory flow, defined as the maximum positive flow recorded from BS to [x0 minus 1 time point] |
| PEF | Liters/minute | peak expiratory flow, defined as the most negative flow recorded from x0 to BE |
| PIP | cm H2O | peak inspiratory pressure, defined as the maximum recorded pressure from BS to [x0 minus 1 time point] |
| Mean flow from PEF | Milliliters | The mean flow observation from the point in time PEF occurred to the point where the breath terminated and a new one begins |
| ipAUC | cm H2O | the inspiratory pressure area under the curve, defined as the integral of the pressure-time curve from BS to [x0 minus 1 time point] |
| epAUC | cm H2O | the expiratory pressure area under the curve, defined as the integral of the pressure-time curve from x0 to BE |
| PEEP | cm H2O | positive end-expiratory pressure, defined as the average of the last 5 data points from the pressure-time curve of each breath |
| Paw | cm H2O | mean airway pressure |
| Dynamic Compliance | Unitless | The pulmonary compliance of the lung at any given point during a breath. This measure is derived via : |

**Table S2**: Descriptive statistics for the all classifiers run on the multiclass classification problem using RUS. ERTC: Extremely Randomized Trees classifier. GBC: Gradient Boosting classifier. MLP; Multi-layer Perceptron. RUS; Random Under-Sampling. DTA; Double-Trigger Asynchrony. BSA; Breath Stacking Asynchrony

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Algorithm | Class | Accuracy | Sensitivity | Specificity |
| **Ensemble** | **Non-PVA** | 0.9473 | 0.9315 | 0.9888 |
|  | **DTA** | 0.9467 | 0.9801 | 0.9439 |
|  | **BSA** | 0.9679 | 0.9098 | 0.9823 |
| **ERTC** | **Non-PVA** | 0.7603 | 0.7323 | 0.8336 |
|  | **DTA** | 0.8743 | 0.9973 | 0.8639 |
|  | **BSA** | 0.8062 | 0.5685 | 0.865 |
| **GBC** | **Non-PVA** | 0.9519 | 0.9382 | 0.9881 |
|  | **DTA** | 0.9534 | 0.9761 | 0.9515 |
|  | **BSA** | 0.9726 | 0.9274 | 0.9838 |
| **MLP** | **Non-PVA** | 0.9315 | 0.9162 | 0.9716 |
|  | **DTA** | 0.9391 | 0.9721 | 0.9363 |
|  | **BSA** | 0.9518 | 0.8693 | 0.9723 |

**Table S3**: Descriptive statistics for the all class ratios run on the multiclass classification using SMOTE and our ensemble classifier. DTA; Double-Trigger Asynchrony. BSA; Breath Stacking Asynchrony

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| SMOTE Ratio | Class | Accuracy | Sensitivity | Specificity |
| **0.1** | **Non-PVA** | 0.9738 | 0.9763 | 0.9672 |
|  | **DTA** | 0.9798 | 0.9069 | 0.9859 |
|  | **BSA** | 0.9783 | 0.9512 | 0.985 |
| **0.2** | **Non-PVA** | 0.9731 | 0.9747 | 0.969 |
|  | **DTA** | 0.9794 | 0.9229 | 0.9842 |
|  | **BSA** | 0.9781 | 0.9476 | 0.9856 |
| **0.3** | **Non-PVA** | 0.9719 | 0.9724 | 0.9705 |
|  | **DTA** | 0.9774 | 0.9362 | 0.9808 |
|  | **BSA** | 0.9785 | 0.9435 | 0.9872 |
| **0.4** | **Non-PVA** | 0.9716 | 0.9707 | 0.9739 |
|  | **DTA** | 0.9753 | 0.9415 | 0.9781 |
|  | **BSA** | 0.9784 | 0.9414 | 0.9875 |
| **0.5** | **Non-PVA** | 0.9713 | 0.9699 | 0.975 |
|  | **DTA** | 0.9753 | 0.9415 | 0.9781 |
|  | **BSA** | 0.9787 | 0.9445 | 0.9872 |
| **0.6** | **Non-PVA** | 0.9708 | 0.969 | 0.9754 |
|  | **DTA** | 0.9747 | 0.9388 | 0.9777 |
|  | **BSA** | 0.9786 | 0.9455 | 0.9868 |
| **0.7** | **Non-PVA** | 0.97 | 0.9678 | 0.9757 |
|  | **DTA** | 0.9732 | 0.9521 | 0.975 |
|  | **BSA** | 0.9782 | 0.9383 | 0.9881 |
| **0.8** | **Non-PVA** | 0.9704 | 0.9676 | 0.9776 |
|  | **DTA** | 0.9736 | 0.9495 | 0.9756 |
|  | **BSA** | 0.9787 | 0.9429 | 0.9875 |
| **0.9** | **Non-PVA** | 0.9705 | 0.9676 | 0.978 |
|  | **DTA** | 0.9742 | 0.9521 | 0.976 |
|  | **BSA** | 0.9786 | 0.9435 | 0.9873 |
| **1.0** | **Non-PVA** | 0.971 | 0.9673 | 0.9806 |
|  | **DTA** | 0.9742 | 0.9601 | 0.9754 |
|  | **BSA** | 0.9793 | 0.9445 | 0.9879 |