

A Bayesian Hierarchical Model for Improving Exercise Rehabilitation in Mechanically Ventilated ICU Patients

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Exercise rehabilitation

- Patients who are mechanically ventilated in the intensive care unit (ICU) as a result of Critical Illness are often left with a range of impairments
- Exercise rehabilitation during mechanical ventilation is considered the best way to ameliorate these long-term impacts, however we currently have no scientific method to easily quantify a patient's level of exercise intensity.
- This is because the current standard measure of exercise intensity, VO_2 , is very difficult to measure in mechanically ventilated patients.
- A broad one-size-fits-all approach is therefore taken to rehabilitation leading to sub-optimal patient outcomes.

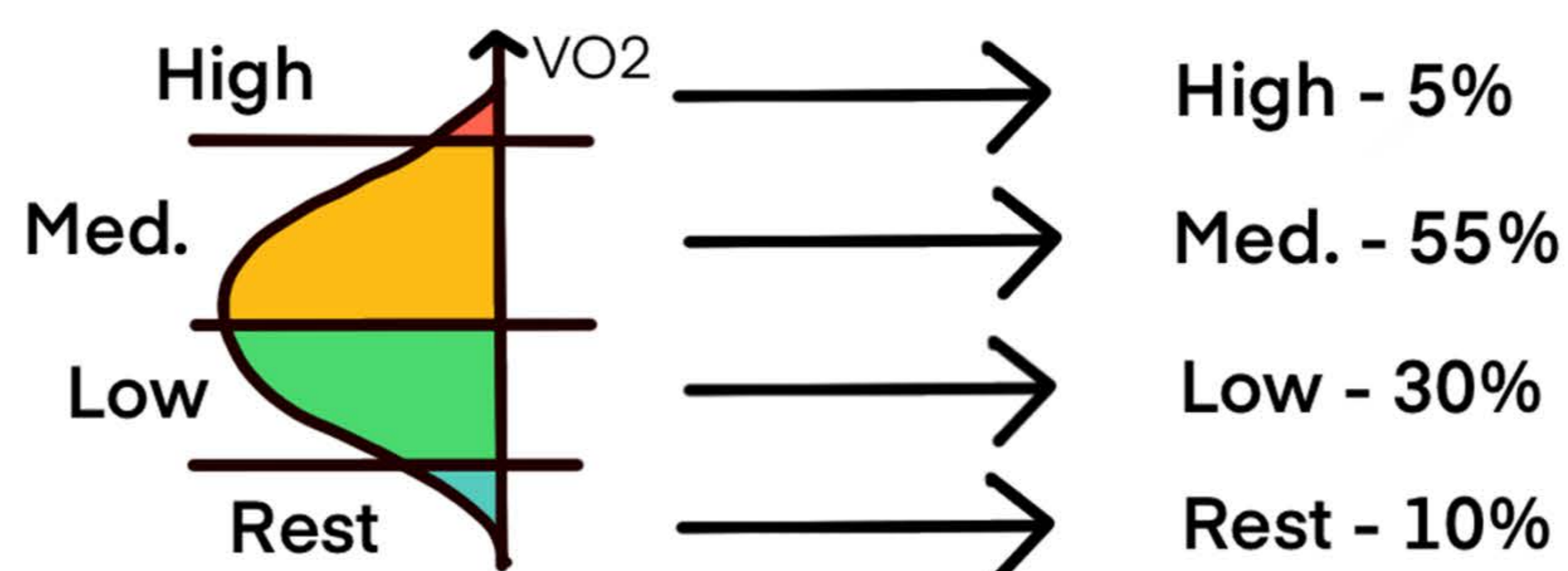
We have developed a prediction model for VO_2 which could help clinicians improve the quality of rehabilitation sessions, improving patient outcomes.

The model

Whenever the patient takes a breath, the model receives physiological information (Tidal Volume, Respiratory Rate, End Tidal CO_2).

The model uses this information to predict VO_2 . Hierarchical and temporal effects are used to account for high levels of between patient and between session heterogeneity and similarity between observations over time.

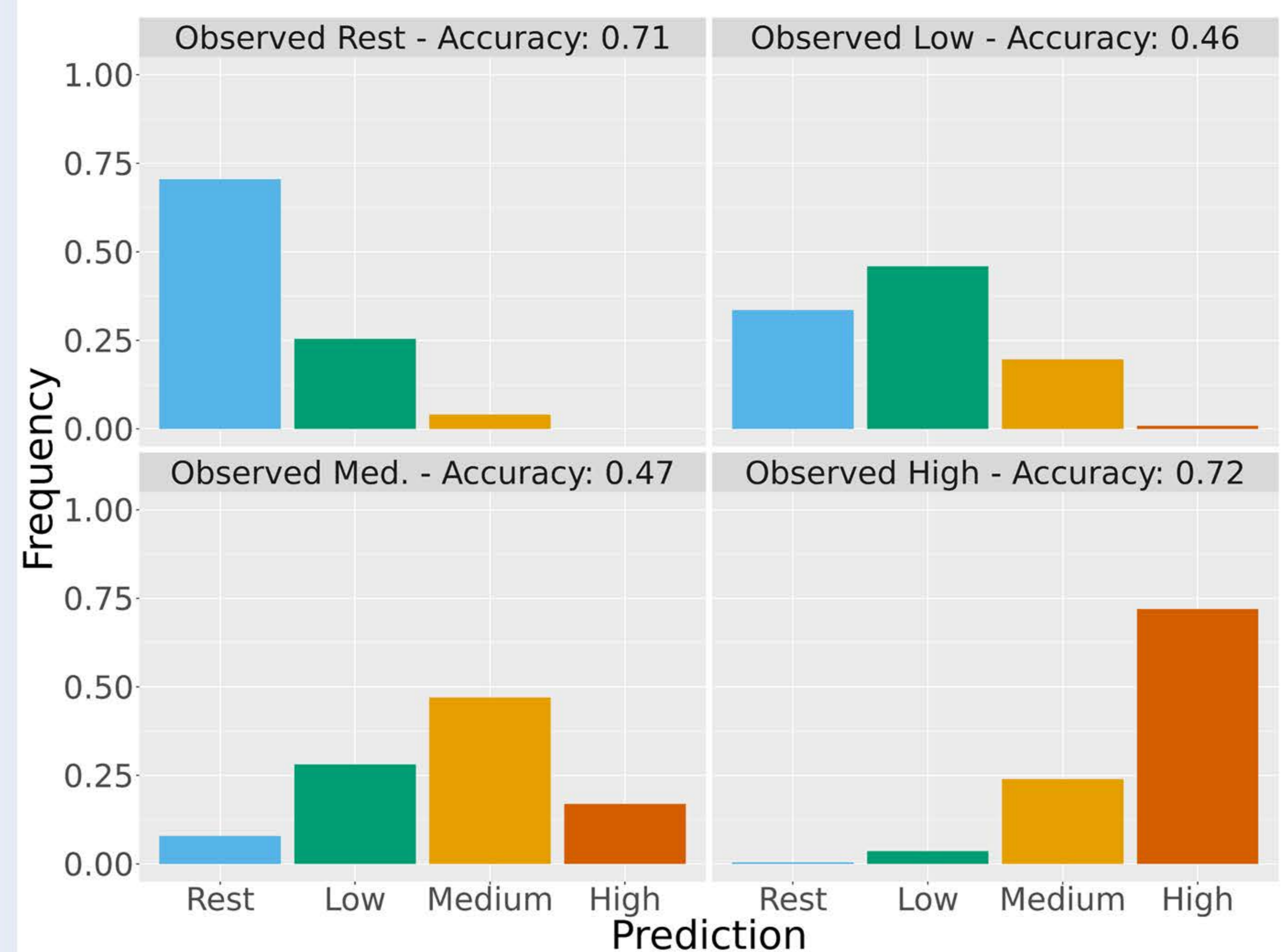
The model returns a posterior predictive distribution for VO_2 .



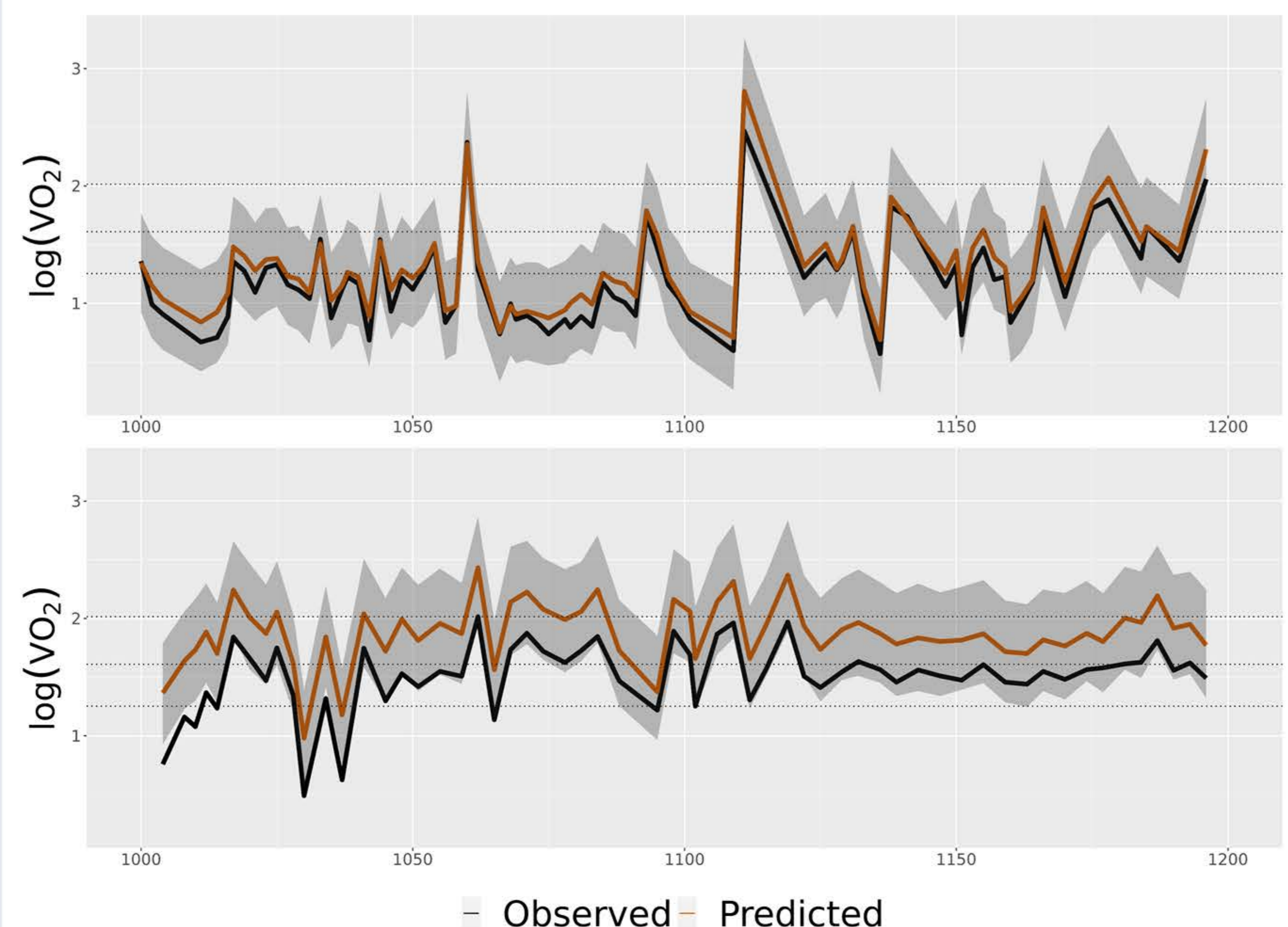
Working in the Bayesian paradigm, we can propagate the uncertainty from the predictive distribution through to classifications for VO_2 for easy interpretation by clinicians

Measuring predictive accuracy

- To validate our model we used leave-one-patient-out cross-validation.
- The model had an overall accuracy of 60% however there was significant variation in accuracy between observed categories.



- Plots of predicted and actual VO_2 show that our model does well in matching the shape of VO_2 over time....



- However in some patients it struggles to match the scale of the curve.
- Both our model and validation results suggest a high level of heterogeneity between rehabilitation sessions limiting the usefulness of single classifications.
- In practice clinicians would have access to probabilistic statements about classifications increasing the practical usefulness of the model.

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