**Supplemental Model performance in samples excluded for missing required data**

48,909 (8.8%) of 558,495 ICU stays were excluded due to missing required data. The most common reason for missing data was laboratory values (about 10%), followed by vital signs (about 5%), and BMI (2%).

After implementing multiple imputations for the ICU stays with missing values, missing data were replaced with ten imputed values for each missing value. The model performance of the new model was generated to compare with new model performance among the non-missing data sample (validation set).

We observed higher model performances of the new model when applied to the imputed data sample, with AUROC= 0.927 for the ICU mortality model, and 0.940 for the hospital mortality model. However, the models tended to over-predict for the sample with missing data, with A: P ratio=0.808 and 0.905 for the hospital model and ICU model, respectively. We did not evaluate the APACHE predictions among this cohort of patients because we could not impute missing features for APACHE without knowing the exact definition of each APACHE input.