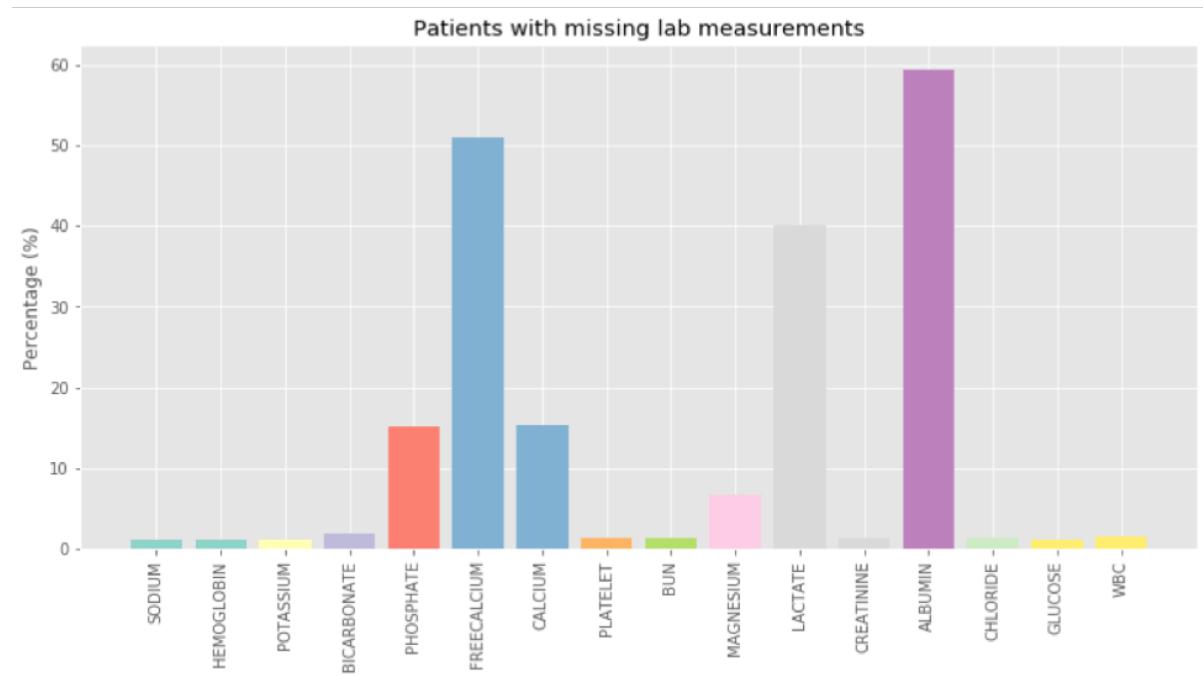


## Supplementary Online Content

### Supplementary Missing Value Analysis

For each ICU stay, we extracted worst first day results for a panel of laboratory tests routinely ordered for ICU patients. Missing data in laboratory tests was handled as follows: if a patient had values for all the tests except albumin, the patient was included in all analyses except that for albumin. The proportion of patients missing each lab test are shown in eFigure 1. Albumin was ordered for only 41% of patients; free (ionized) calcium for 50%; serum lactate for 60%; with the remainder of the study laboratory tests ordered for more than 80% of patients.

eFigure 1: Summary of the percentages of missing values for various lab test results.



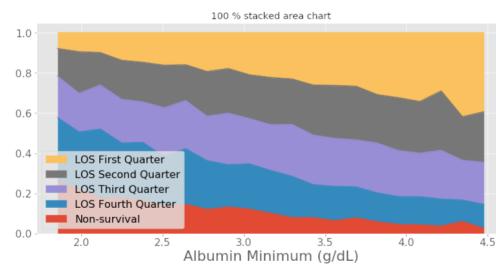
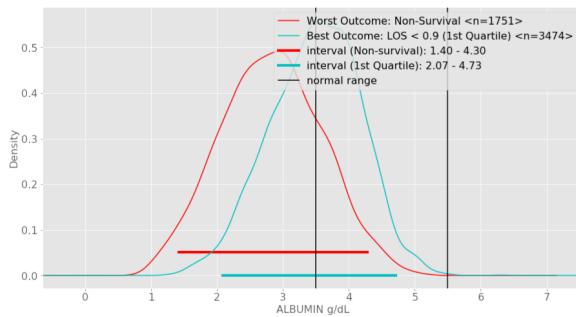
### Supplementary Results

For each stay, we extracted worst first day results for a panel of laboratory tests routinely ordered for ICU patients. We focused on clinically relevant laboratory values: minimum for albumin, ionized calcium, hemoglobin, and platelets; maximum for creatinine and lactate; and both minimum and maximum for bicarbonate, calcium, magnesium, phosphate, potassium, sodium, and white blood cell count. The laboratory tests included in manuscript are excluded in the supplementary results.

#### Minimum Values

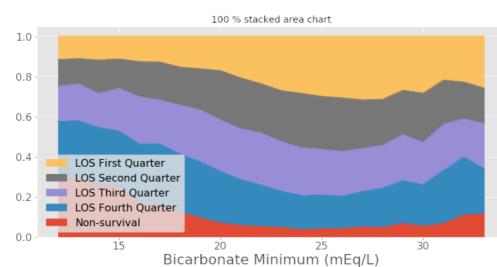
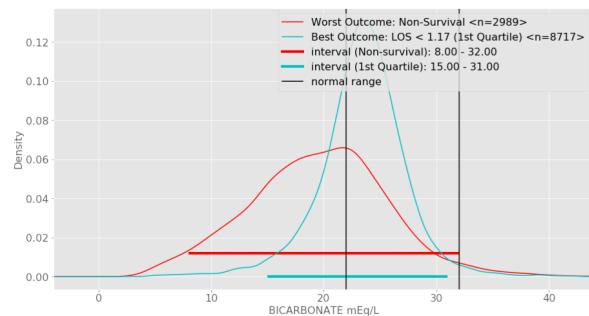
eFigure2: Albumin and Bicarbonate minimum result plots

#### Minimum albumin measurement on first ICU admission vs ICU mortality



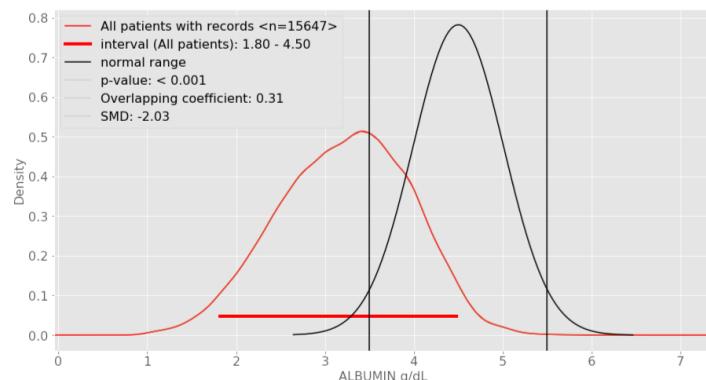
Albumin Minimum (g/dL)

#### Minimum bicarbonate measurement on first ICU admission vs ICU mortality



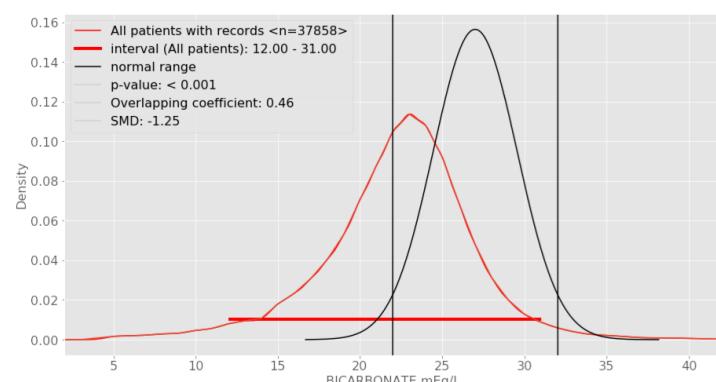
Bicarbonate Minimum (mmol/L)

#### Minimum albumin measurement on first ICU admission vs ICU mortality



Albumin Minimum (g/dL)

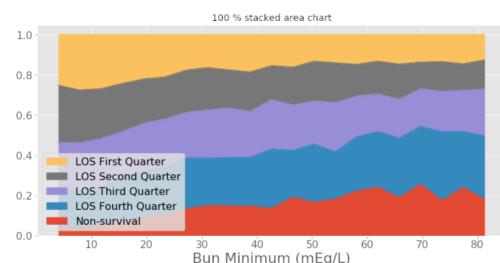
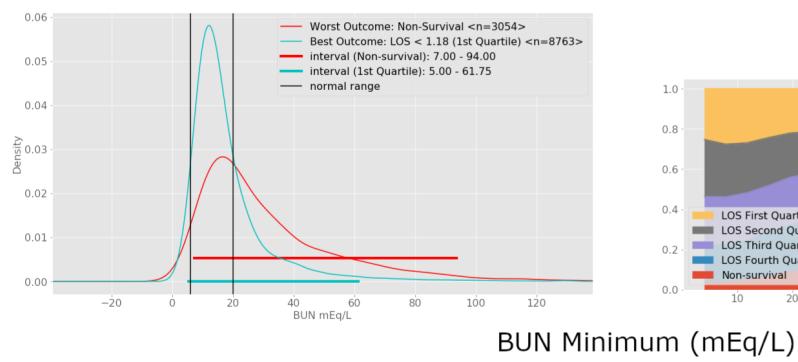
#### Minimum bicarbonate measurement on first ICU admission vs ICU mortality



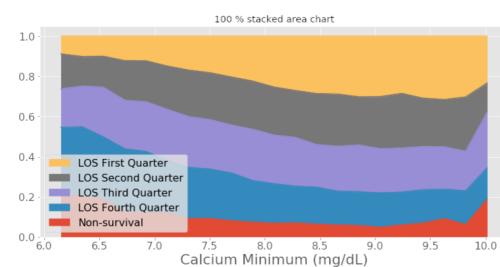
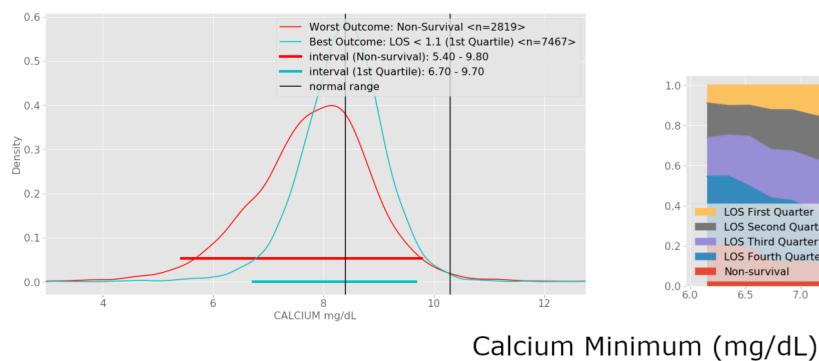
Bicarbonate Minimum (mEq/L)

**eFigure 3: BUN and Calcium minimum result plots**

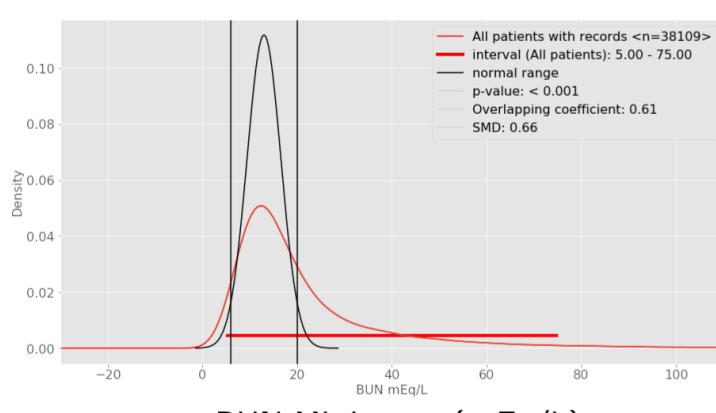
Minimum bun measurement on first ICU admission vs ICU mortality



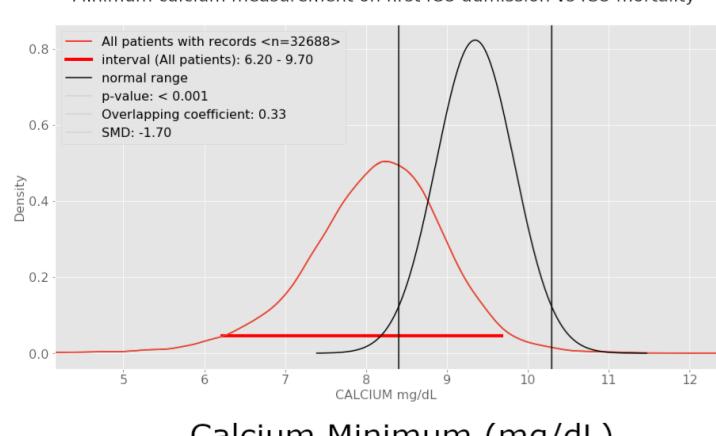
Minimum calcium measurement on first ICU admission vs ICU mortality



Minimum bun measurement on first ICU admission vs ICU mortality

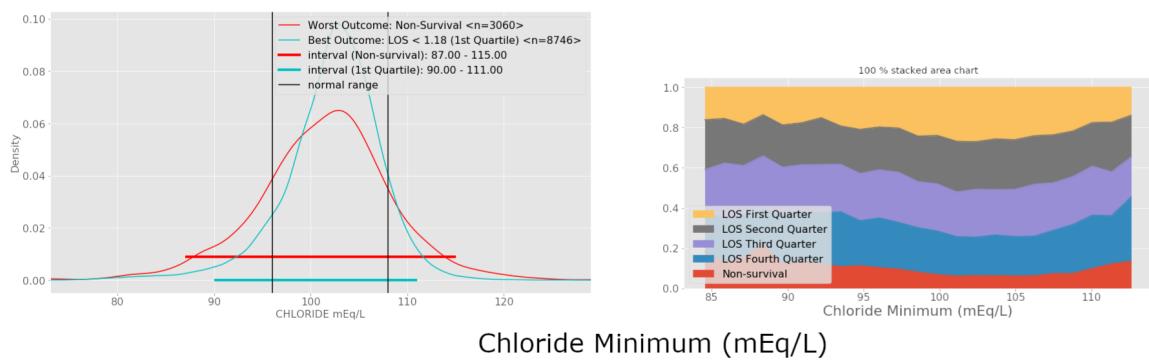


Minimum calcium measurement on first ICU admission vs ICU mortality

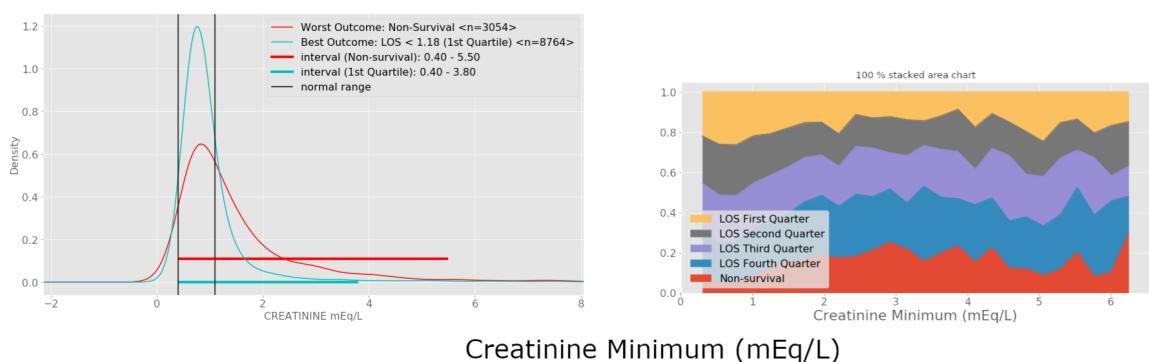


eFigure 4: Chloride and Creatinine minimum

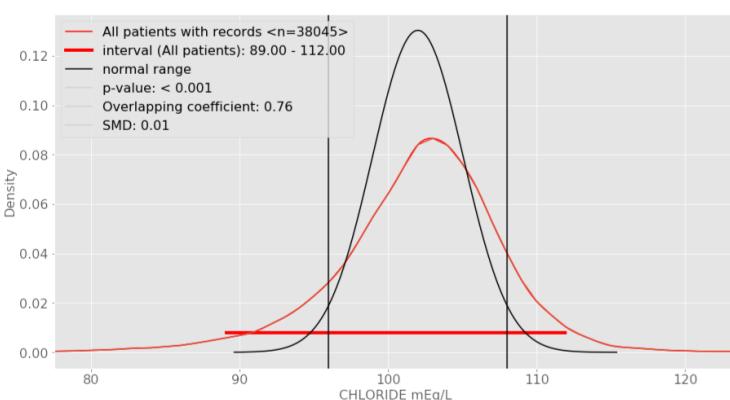
Minimum chloride measurement on first ICU admission vs ICU mortality



Minimum creatinine measurement on first ICU admission vs ICU mortality

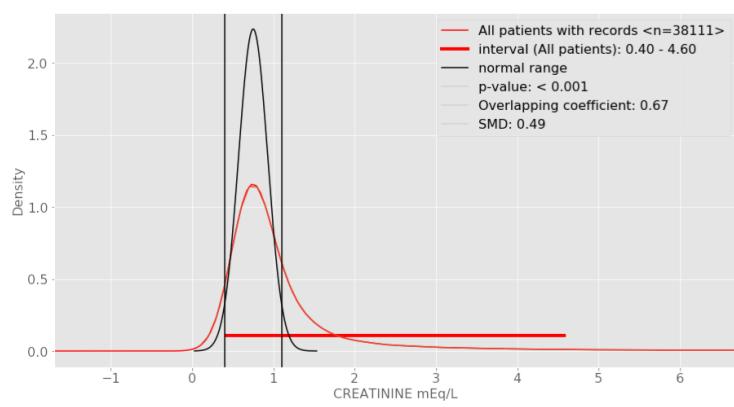


Minimum chloride measurement on first ICU admission vs ICU mortality



Chloride Minimum (mEq/L)

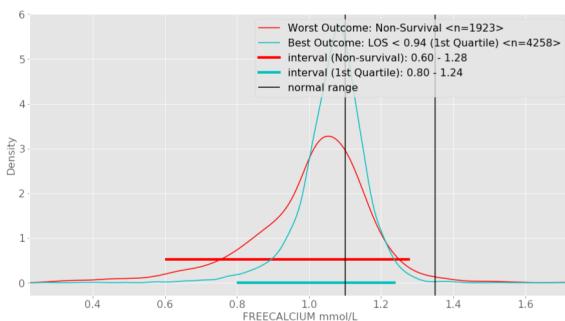
Minimum creatinine measurement on first ICU admission vs ICU mortality



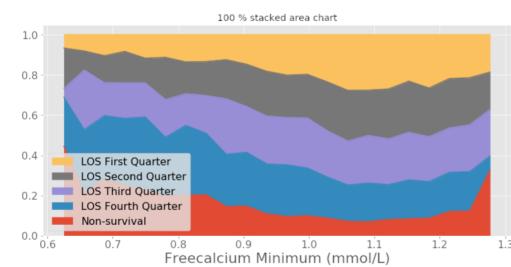
Creatinine Minimum (mEq/L)

eFigure 5: Freecalcium and lactate minimum

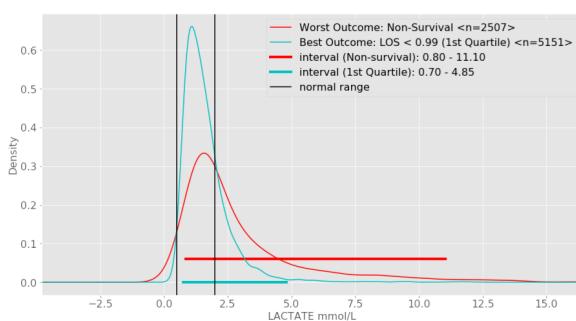
Minimum freecalcium measurement on first ICU admission vs ICU mortality



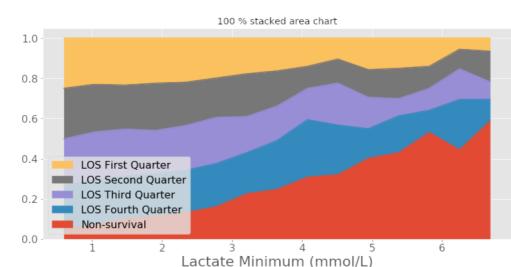
Free calcium Minimum (mmol/L)



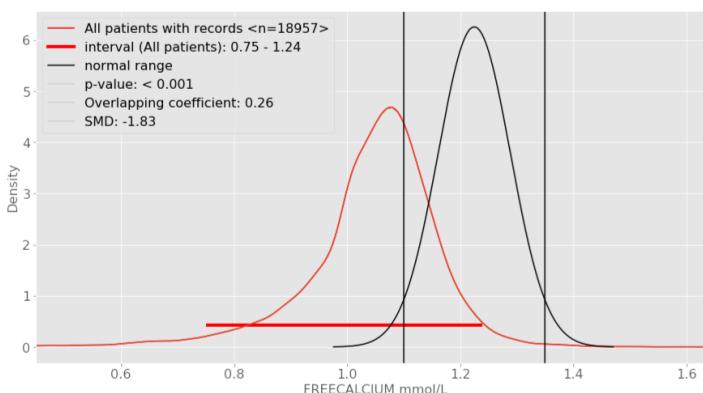
Minimum lactate measurement on first ICU admission vs ICU mortality



Lactate Minimum (mmol/L)

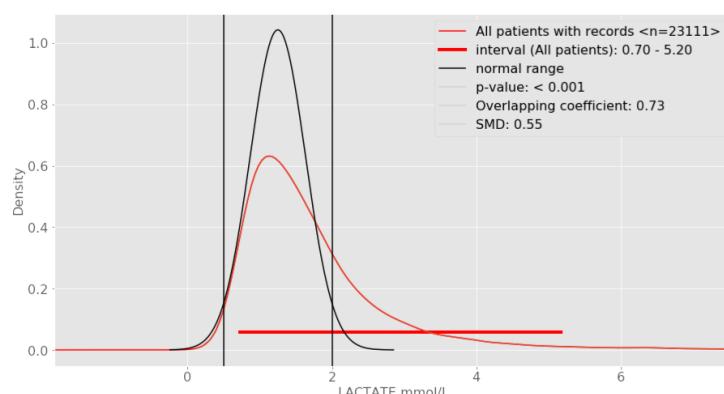


Minimum freecalcium measurement on first ICU admission vs ICU mortality



Freecalcium Minimum (mmol/L)

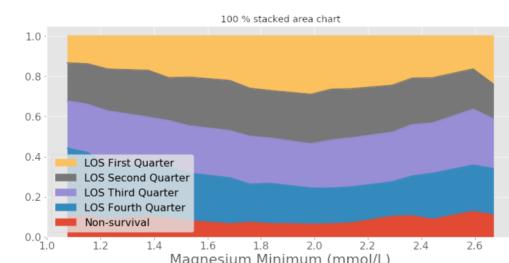
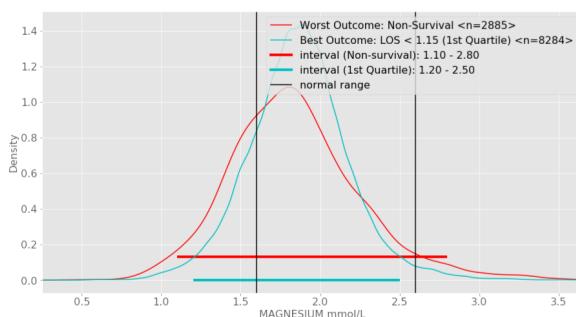
Minimum lactate measurement on first ICU admission vs ICU mortality



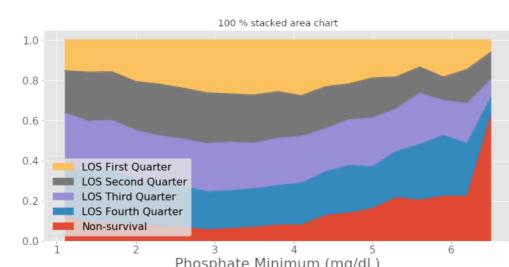
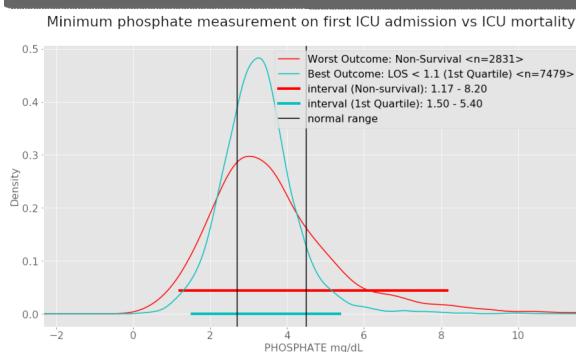
Lactate Minimum (mmol/L)

eFigure 6: Magnesium and Phosphate minimum

Minimum magnesium measurement on first ICU admission vs ICU mortality

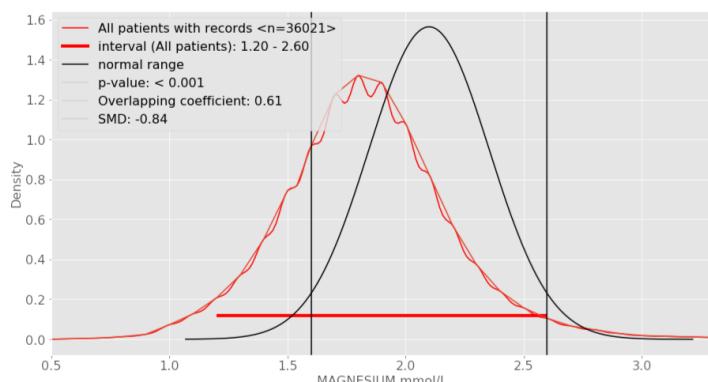


Magnesium Minimum (mmol/L)



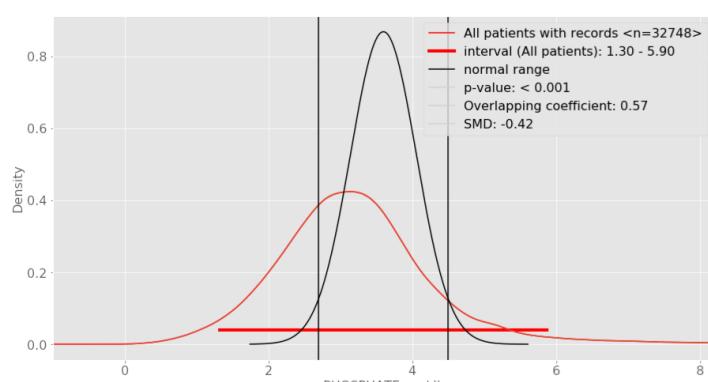
Phosphate Minimum (mg/dL)

Minimum magnesium measurement on first ICU admission vs ICU mortality



Magnesium Minimum (mmol/L)

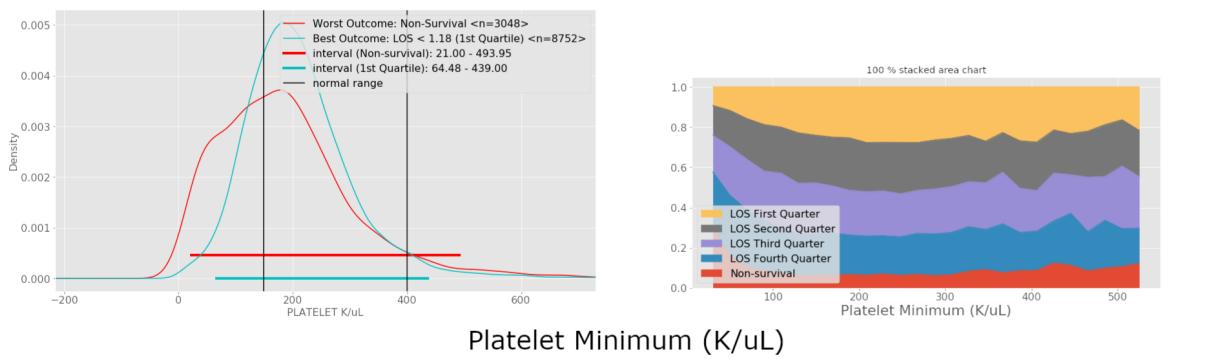
Minimum phosphate measurement on first ICU admission vs ICU mortality



Phosphate Minimum (mg/dL)

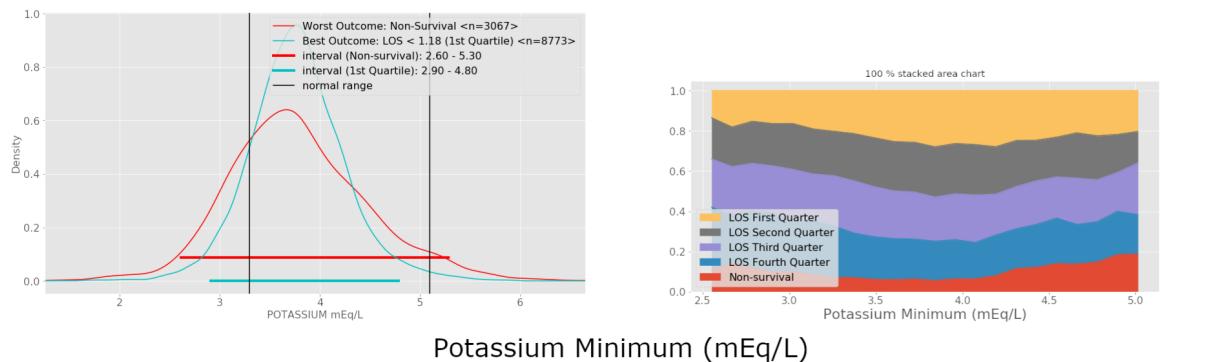
eFigure 7: Platelet and Potassium minimum

Minimum platelet measurement on first ICU admission vs ICU mortality



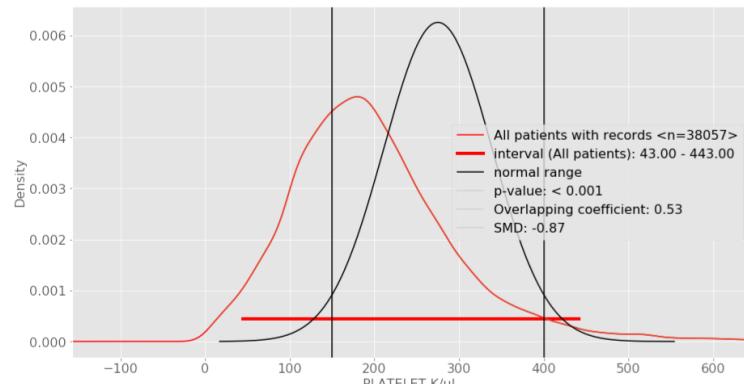
Platelet Minimum (K/uL)

Minimum potassium measurement on first ICU admission vs ICU mortality



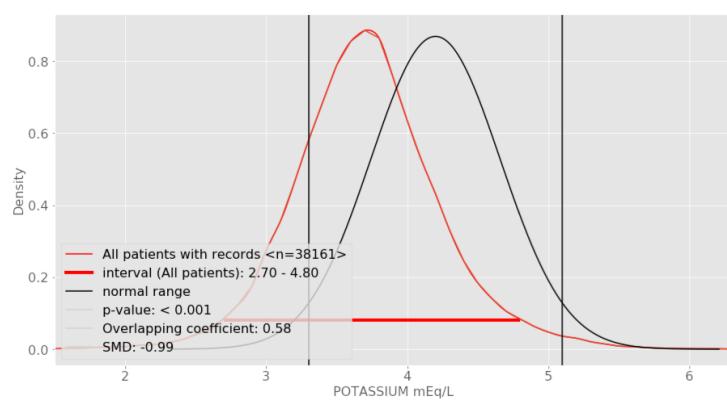
Potassium Minimum (mEq/L)

Minimum platelet measurement on first ICU admission vs ICU mortality



Platelet Minimum (K/uL)

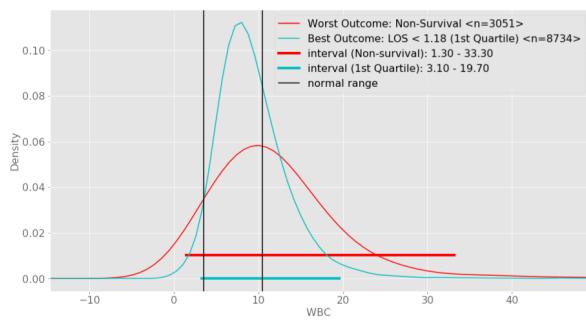
Minimum potassium measurement on first ICU admission vs ICU mortality



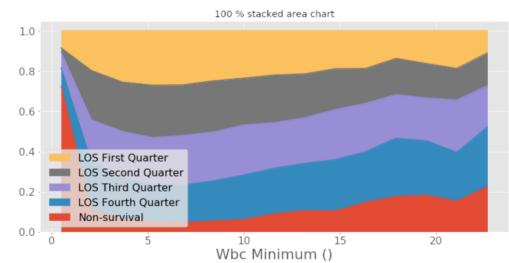
Potassium Minimum (mEq/L)

eFigure 8: WBC minimum

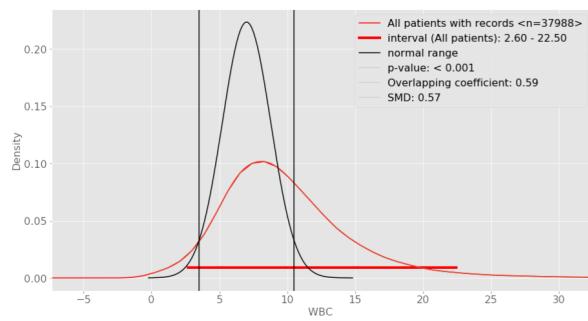
Minimum wbc measurement on first ICU admission vs ICU mortality



WBC Minimum



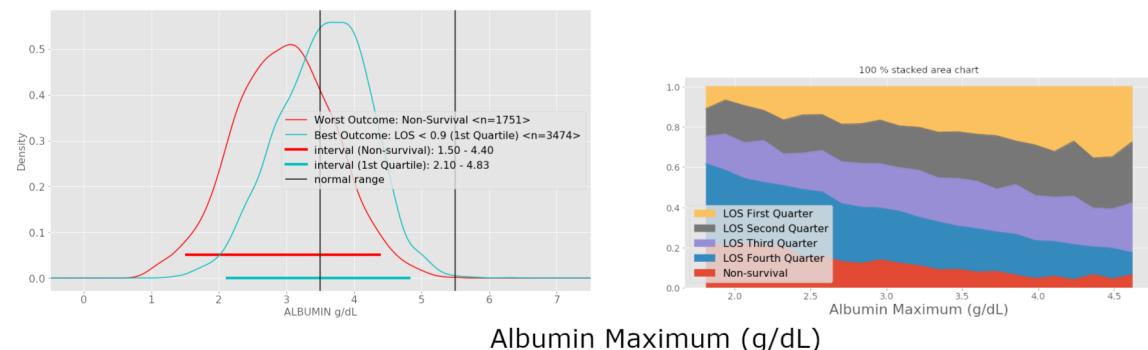
Minimum wbc measurement on first ICU admission vs ICU mortality



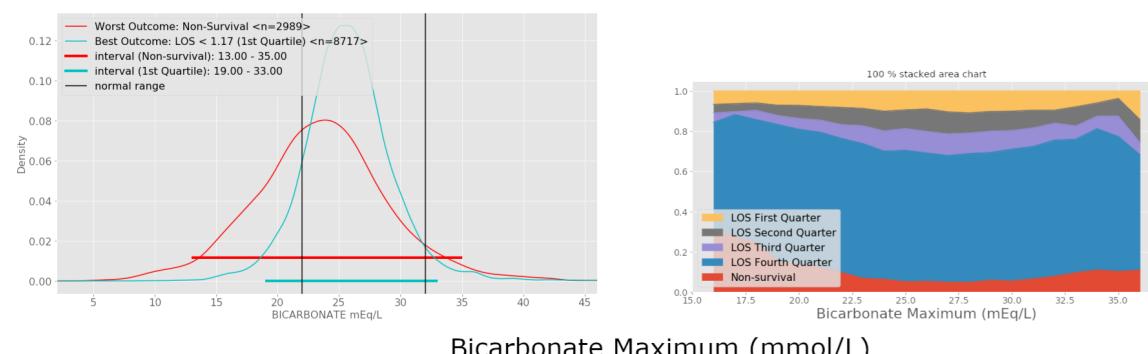
## Maximum Values

eFigure 9: Albumin and Bicarbonate maximum

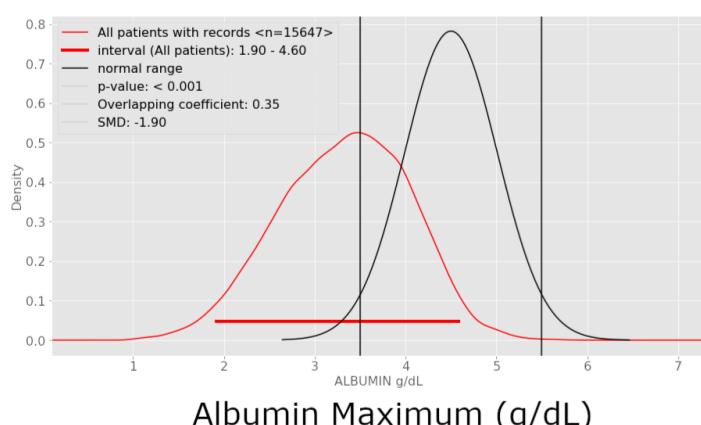
Maximum albumin measurement on first ICU admission vs ICU mortality



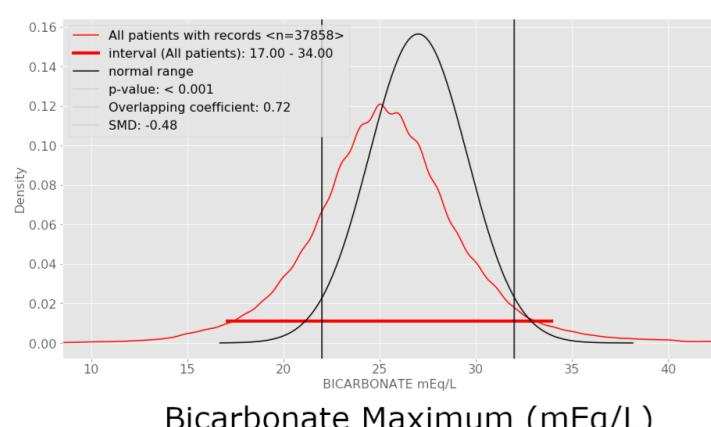
Maximum bicarbonate measurement on first ICU admission vs ICU mortality



Maximum albumin measurement on first ICU admission vs ICU mortality

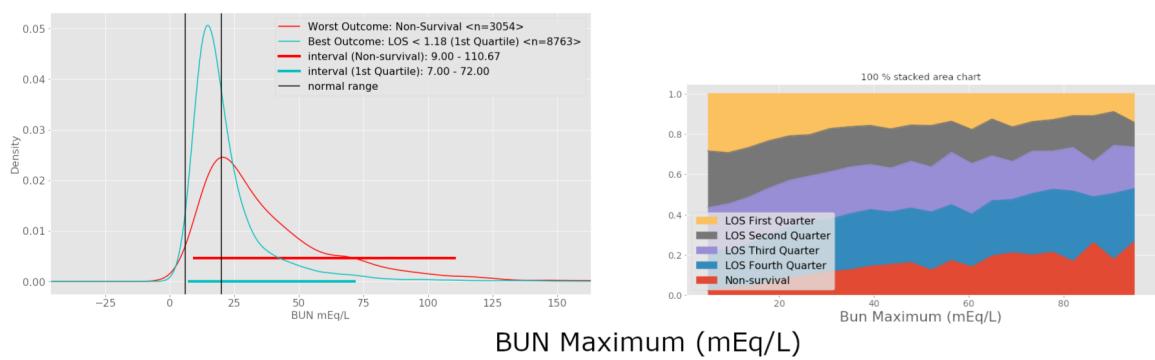


Maximum bicarbonate measurement on first ICU admission vs ICU mortality

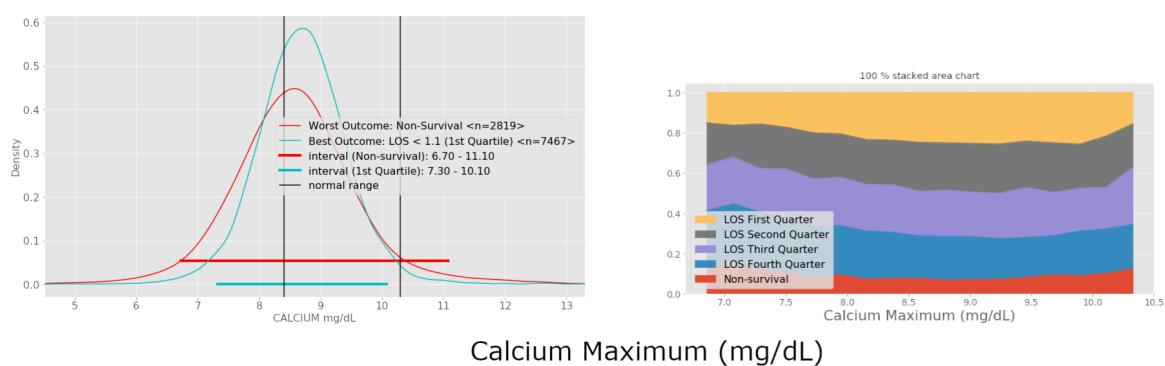


**eFigure 10: BUN and Calcium maximum**

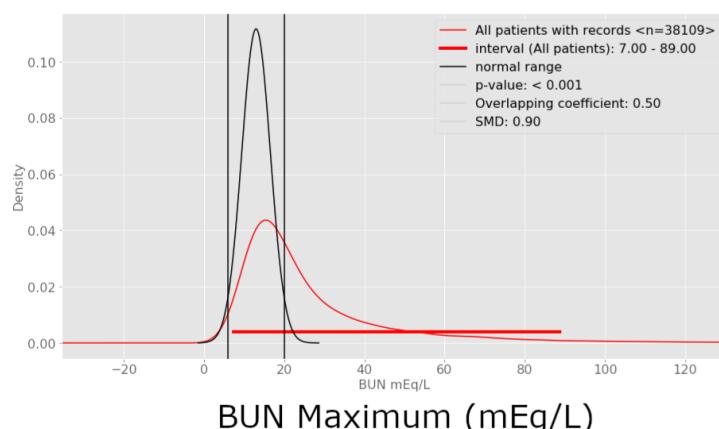
Maximum bun measurement on first ICU admission vs ICU mortality



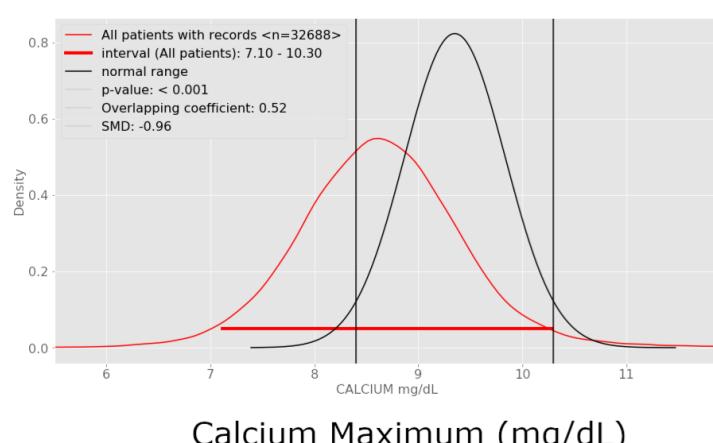
Maximum calcium measurement on first ICU admission vs ICU mortality



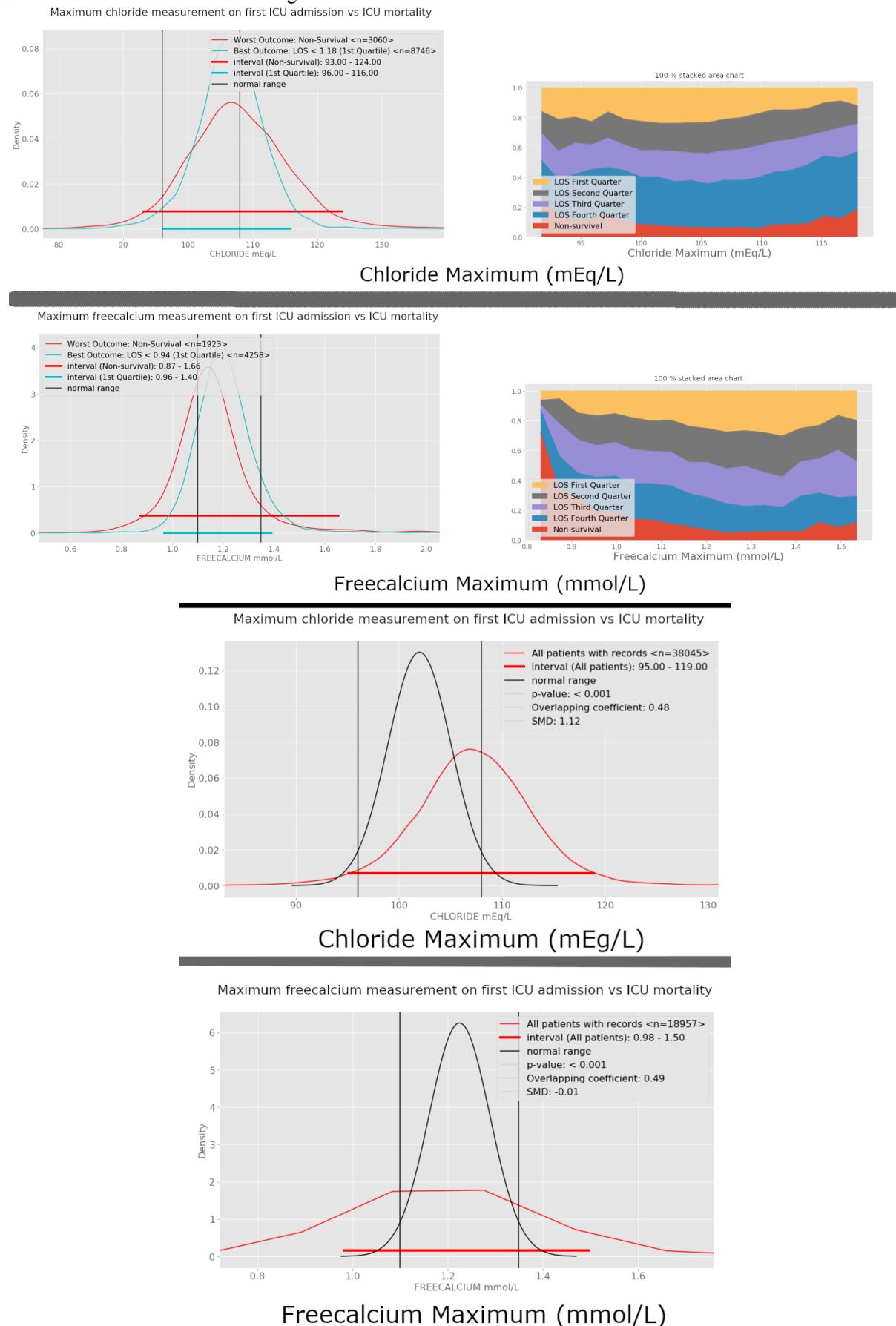
Maximum bun measurement on first ICU admission vs ICU mortality



Maximum calcium measurement on first ICU admission vs ICU mortality

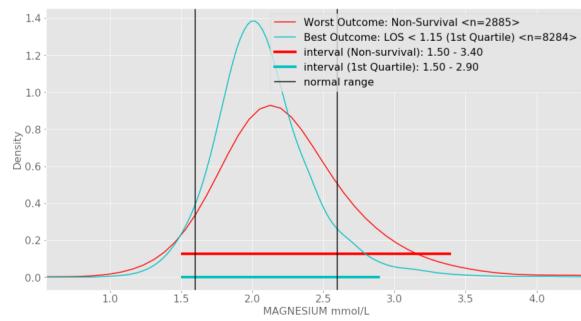


eFigure 11: Chloride and Freecalcium maximum

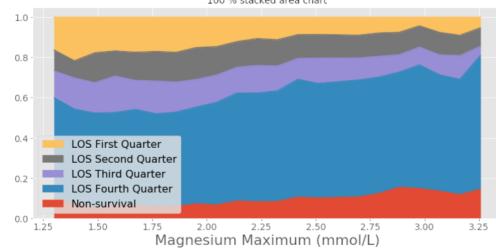


eFigure 12: Magnesium and Phosphate maximum

Maximum magnesium measurement on first ICU admission vs ICU mortality

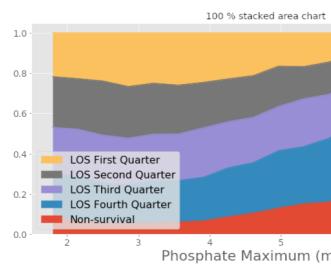
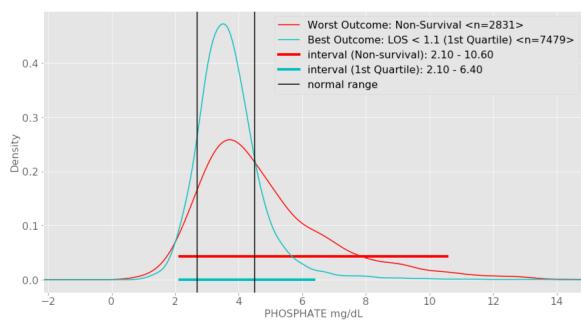


100 % stacked area chart



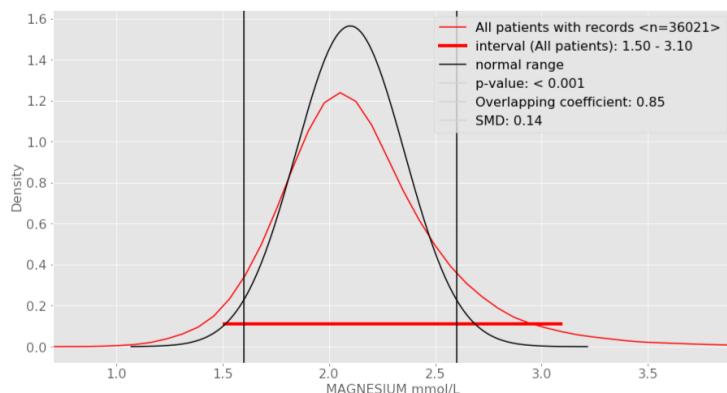
Magnesium Maximum (mmol/L)

Maximum phosphate measurement on first ICU admission vs ICU mortality



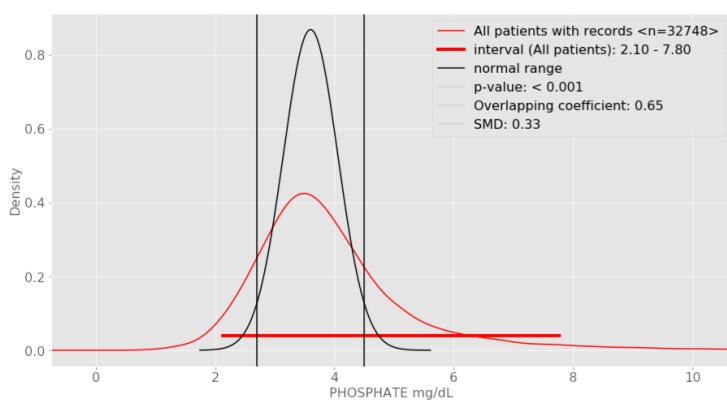
Phosphate Maximum (mg/dL)

Maximum magnesium measurement on first ICU admission vs ICU mortality



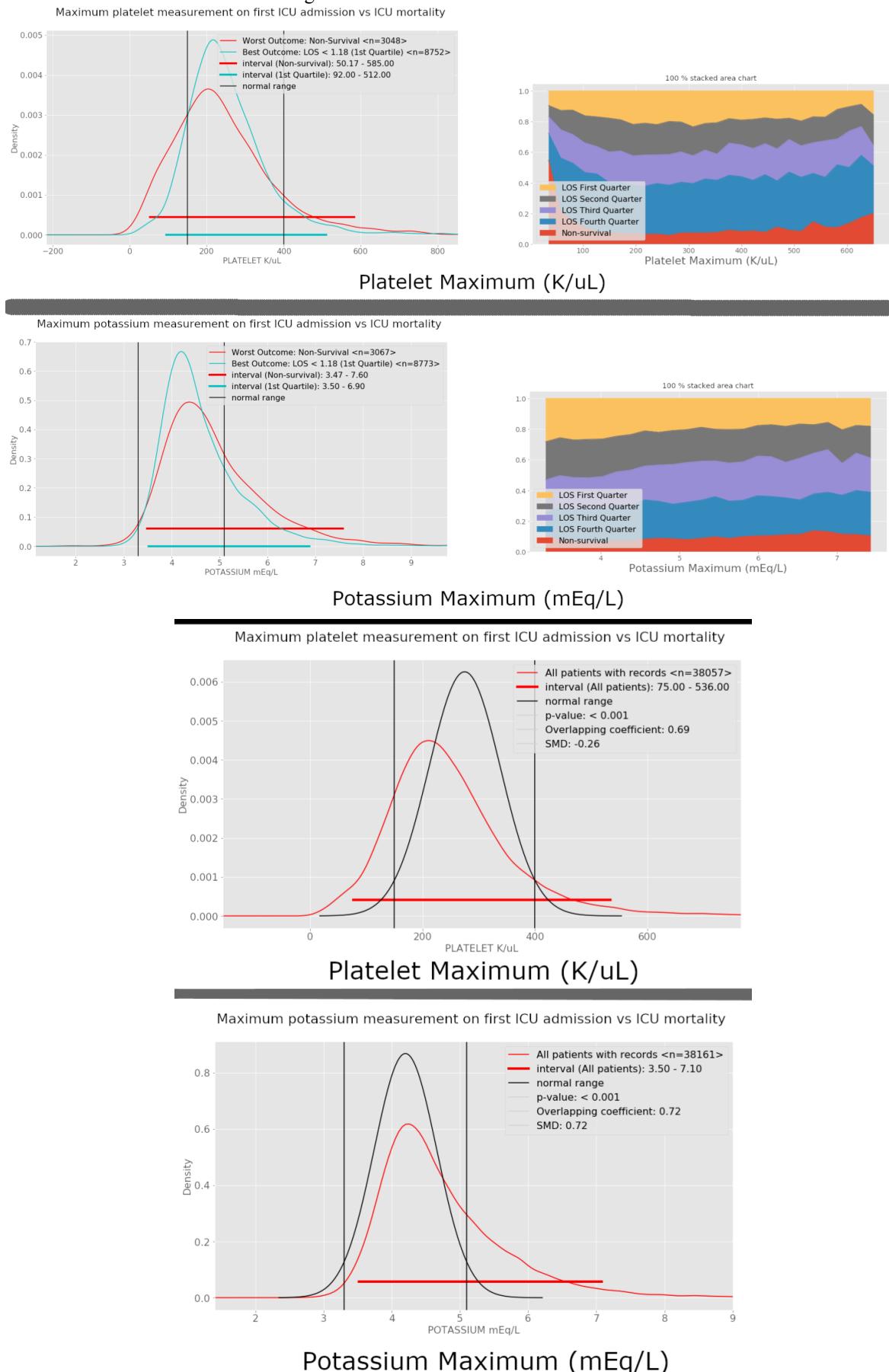
Magnesium Maximum (mmol/L)

Maximum phosphate measurement on first ICU admission vs ICU mortality



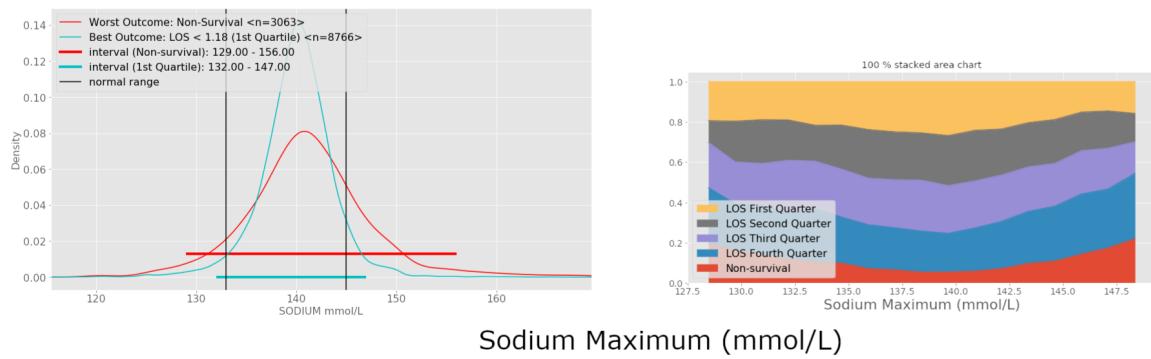
Phosphate Maximum (mg/dL)

eFigure 13: Platelet and Potassium maximum



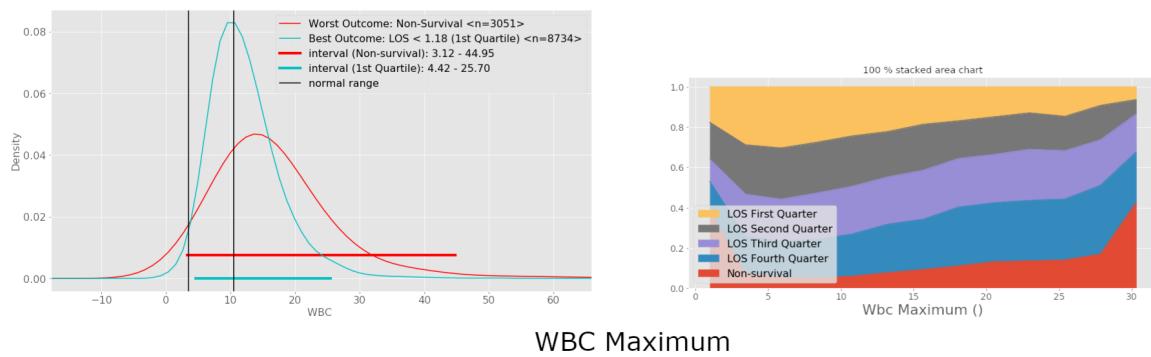
**eFigure 14: Sodium and WBC maximum**

Maximum sodium measurement on first ICU admission vs ICU mortality



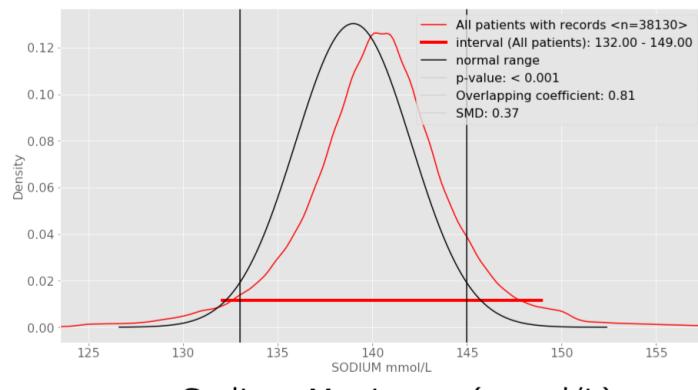
Sodium Maximum (mmol/L)

Maximum wbc measurement on first ICU admission vs ICU mortality



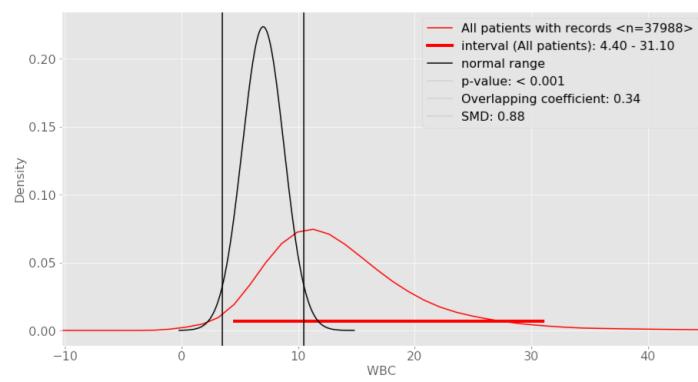
WBC Maximum

Maximum sodium measurement on first ICU admission vs ICU mortality



Sodium Maximum (mmol/L)

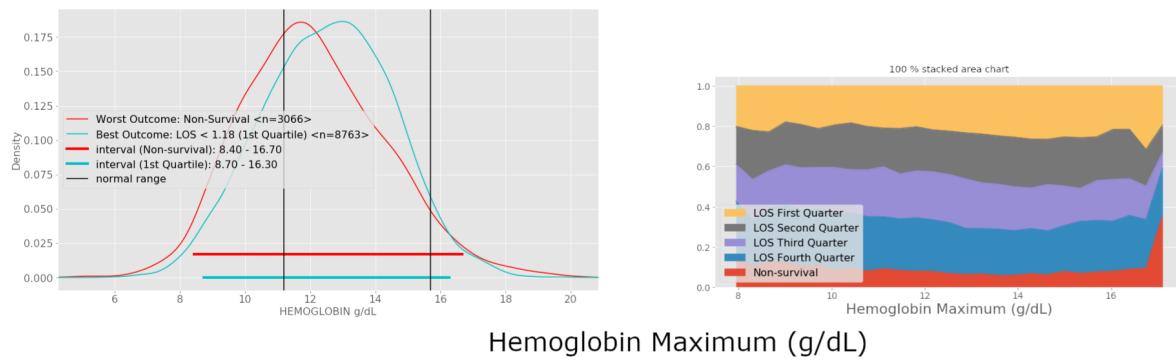
Maximum wbc measurement on first ICU admission vs ICU mortality



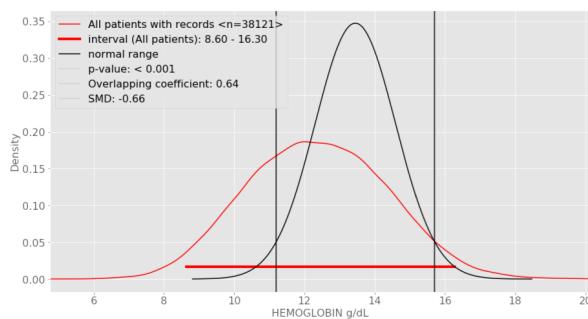
WBC Maximum

eFigure 15: Hemoglobin maximum

Maximum hemoglobin measurement on first ICU admission vs ICU mortality



Maximum hemoglobin measurement on first ICU admission vs ICU mortality



## Supplementary Tables

More details of Table 2: Overlap Between Laboratory Distributions of all ICU patients, Best Outcome patients, and Worst Outcome patients with the standard reference interval is provided in eTable 1. All numbers are rounded to the third decimal place. Confidence intervals of OVL and SMD are also provided. The confidence intervals were computed using bootstrap method: first, we resampled data from their distribution for 100 times and calculated OVL and SMD respectively. Second step, we ordered OVL and SMD, chose the value at 2.5% percentile as the confidence interval lower bound and the 97.5% as the upper bound. The selected values form 95% confidence interval.

**eTable 1: Overlap Between Laboratory Distributions of all ICU patients, Best Outcome patients, and Worst Outcome patients with the standard reference interval**

	All ICU Patients vs Standard Reference Interval		Best Outcome Patients vs Standard Reference Interval		Worst Outcome Patients vs Standard Reference Interval	
	OVL	SMD	OVL	SMD	OVL	SMD
Albumin (Min)	0.311 [0.308, 0.312]	-2.032 [-2.055, -2.026]	0.403 [0.401, 0.413]	-1.686 [-1.707, -1.671]	0.194 [0.189, 0.216]	-2.568 [-2.623, -2.503]
Bicarbonate (Max) (Min)	0.723 [0.721, 0.726]	-0.478 [-0.478, -0.467]	0.774 [0.768, 0.777]	-0.405 [-0.418, -0.401]	0.543 [0.533, 0.579]	-0.793 [-0.842, -0.753]
	0.459 [0.454, 0.463]	-1.253 [-1.261, -1.246]	0.531 [0.524, 0.532]	-1.093 [-1.109, -1.089]	0.328 [0.322, 0.356]	-1.583 [-1.640, -1.525]

Bilirubin (Max)	0.496 [0.492, 0.496]	0.898 [0.888, 0.911]	0.574 [0.574, 0.590]	0.763 [0.750, 0.764]	0.284 [0.278, 0.302]	1.284 [1.257, 1.320]
Creatinine (Max)	0.531 [0.527, 0.534]	0.635 [0.626, 0.650]	0.573 [0.573, 0.605]	0.508 [0.502, 0.517]	0.334 [0.329, 0.357]	1.040 [1.011, 1.043]
Glucose (Max) (Min)	0.093 [0.091, 0.095]	1.350 [1.323, 1.385]	0.134 [0.125, 0.134]	1.212 [1.205, 1.300]	0.077 [0.076, 0.080]	1.607 [1.568, 1.687]
	0.399 [0.395, 0.402]	0.938 [0.935, 0.956]	0.417 [0.414, 0.419]	0.960 [0.955, 0.966]	0.287 [0.285, 0.301]	0.932 [0.913, 0.965]
Hemoglobin (Min)	0.326 [0.326, 0.329]	-1.802 [-1.813, -1.794]	0.398 [0.398, 0.403]	-1.538 [-1.540, -1.534]	0.302 [0.297, 0.327]	-1.812 [-1.882, -1.743]
Lactate (Max)	0.406 [0.403, 0.406]	0.989 [0.986, 0.989]	0.467 [0.463, 0.471]	0.951 [0.912, 0.957]	0.234 [0.232, 0.241]	1.278 [1.271, 1.307]
Magnesium (Max) (Min)	0.854 [0.852, 0.860]	0.135 [0.122, 0.143]	0.857 [0.856, 0.861]	-0.040 [-0.051, -0.031]	0.734 [0.718, 0.756]	0.236 [0.197, 0.247]
	0.611 [0.606, 0.614]	-0.839 [-0.845, -0.826]	0.650 [0.647, 0.654]	-0.807 [-0.818, -0.799]	0.591 [0.591, 0.610]	-0.719 [-0.746, -0.704]
Phosphate (Max) (Min)	0.650 [0.650, 0.655]	0.331 [0.323, 0.341]	0.705 [0.705, 0.716]	0.163 [0.161, 0.173]	0.461 [0.461, 0.467]	0.790 [0.790, 0.824]
	0.574 [0.572, 0.576]	-0.423 [-0.437, -0.412]	0.632 [0.632, 0.642]	-0.428 [-0.434, -0.405]	0.485 [0.485, 0.523]	0.035 [0.028, 0.083]
Platelet <u>count</u> (Min)	0.525 [0.522, 0.531]	-0.873 [-0.876, -0.857]	0.575 [0.571, 0.577]	-0.753 [-0.773, -0.750]	0.481 [0.473, 0.507]	-0.916 [-0.950, -0.834]
Potassium (Max) (Min)	0.722 [0.719, 0.725]	0.723 [0.722, 0.729]	0.774 [0.769, 0.775]	0.611 [0.602, 0.628]	0.649 [0.639, 0.669]	0.823 [0.774, 0.851]
	0.584 [0.580, 0.588]	-0.991 [-1.004, -0.969]	0.618 [0.610, 0.620]	-0.907 [-0.915, -0.897]	0.622 [0.611, 0.647]	-0.706 [-0.764, -0.653]
Sodium (Max) (Min)	0.806 [0.806, 0.812]	0.368 [0.360, 0.375]	0.826 [0.818, 0.837]	0.314 [0.309, 0.341]	0.687 [0.679, 0.706]	0.451 [0.441, 0.505]
	0.716 [0.713, 0.715]	-0.656 [-0.668, -0.661]	0.767 [0.759, 0.773]	-0.594 [-0.604, -0.579]	0.681 [0.681, 0.710]	-0.587 [-0.605, -0.535]
WBC Count (Max) (Min)	0.340 [0.338, 0.346]	0.881 [0.827, 1.002]	0.411 [0.410, 0.415]	0.776 [0.738, 0.870]	0.256 [0.256, 0.266]	0.694 [0.587, 0.741]
	0.586 [0.584, 0.589]	0.569 [0.524, 0.659]	0.636 [0.643, 0.648]	0.507 [0.483, 0.545]	0.396 [0.380, 0.410]	0.499 [0.436, 0.602]
Calcium (Max) (Min)	0.520 [0.514, 0.524]	-0.955 [-0.983, -0.924]	0.552 [0.552, 0.559]	-1.019 [-1.031, -0.996]	0.488 [0.488, 0.516]	-0.690 [-0.790, -0.690]
	0.333 [0.333, 0.338]	-1.704 [-1.711, -1.696]	0.391 [0.389, 0.397]	-1.558 [-1.567, -1.541]	0.274 [0.270, 0.300]	-1.758 [-1.849, -1.717]

Ionized Calcium (Min)	0.258 [0.258, 0.267]	-1.833 [- 1.843, - 1.823]	0.266 [0.266, 0.276]	-1.966 [- 1.979, - 1.939]	0.262 [0.255, 0.286]	-1.655 [- 1.724, - 1.622]
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