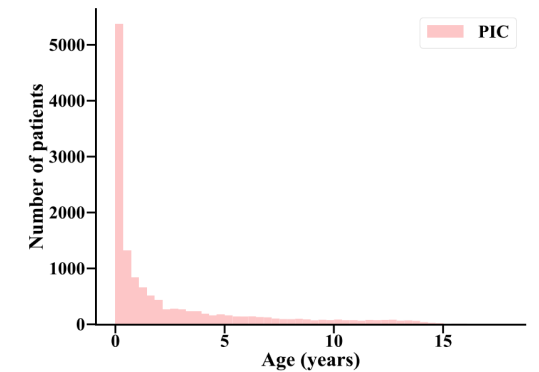


# Predicting In-hospital Mortality of Patients in the Paediatric ICU

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# Data



- PIC (Paediatric Intensive Care) database is a large, single-center database comprising information relating to patients admitted to critical care units at the **Children's Hospital of Zhejiang University School of Medicine**. It is a supplement to the well-known MIMIC database which provided a real clinical database for many data science researchers and supported many research projects. We hope this open paediatric intensive care database will also help improve the quality of intensive care for children.
  - <http://pic.nbscn.org>
  - Xian Zeng#, Gang Yu#, Yang Lu#, Linhua Tan, Xiuqing Wu, Shanshan Shi, Huilong Duan, Qiang Shu\* and Haomin Li\*. PIC, a paediatric-specific intensive care database. Scientific Data 2020 7:14 DOI:[doi.org/10.1038/s41597-020-0355-4](https://doi.org/10.1038/s41597-020-0355-4). Available from: <https://www.nature.com/articles/s41597-020-0355-4>

# Data

- Tables
  - ADMISSIONS
  - CHARTEVENTS
  - LABEVENTS
- Extract min/max values in the first 24 hours after admission
  - 1109 features
  - Impute missing values with 0

# Models

- PRISM III
  - Pollack, Murray M., Kantilal M. Patel, and Urs E. Ruttimann. "PRISM III: an updated Pediatric Risk of Mortality score." Critical care medicine 24.5 (1996): 743-752.
- Logistic Regression (LR)
- Random Forest (RF)
  - n\_estimators=100

# PRISM III

## PRISM III

### CARDIOVASCULAR/NEUROLOGIC VITAL SIGNS (1-6)

#### Systolic Blood Pressure (mm Hg)

Measurement	Score = 3	Score = 7
Neonate	40-55	< 40
Infant	45-65	< 45
Child	55-75	< 55
Adolescent	65-85	< 65

#### Heart Rate (beats per minute)

Measurement	Score = 3	Score = 4
Neonate	215-225	> 225
Infant	215-225	> 225
Child	185-205	> 205
Adolescent	145-155	> 155

#### Temperature

Measurement	Score = 3
All Ages	< 33 °C (91.4 °F) or > 40.0 °C (104.0 °F)

#### Pupillary Reflexes

Measurement	Score = 7	Score = 11
All Ages	One fixed,	Both fixed one reactive

#### Mental Status

Measurement	Score = 5
All Ages	Stupor/Coma (GCS < 8)

### ACID-BASE/BLOOD GASES (1,2,7,8)

#### Acidosis (Total CO<sub>2</sub> (mmol/L) or pH)

Measurement	Score = 2	Score = 6
All Ages	pH 7.0-7.28 or total CO <sub>2</sub> 5-16.9	pH < 7.0 or total CO <sub>2</sub> < 5

#### Total CO<sub>2</sub> (mmol/L)

Measurement	Score = 4
All Ages	> 34.0

#### pH

Measurement	Score = 2	Score = 3
All Ages	7.48-7.55	> 7.55

#### PaO<sub>2</sub> (mm Hg)

Measurement	Score = 3	Score = 6
All Ages	42.0-49.9	< 42.0

#### PCO<sub>2</sub> (mm Hg)

Measurement	Score = 1	Score = 3
All Ages	50.0-75.0	> 75.0

### CHEMISTRY TESTS (1,2,9)

#### Glucose

Measurement	Score = 2
All ages	> 200 mg/dL or > 11.0 mmol/L

#### Potassium (mmol/L)

Measurement	Score = 3
All ages	> 6.9

continued

## PRISM III (continued)

#### Creatinine

Measurement	Score = 2
Neonate	> 0.85 mg/dL or > 75 μmol/L
Infant	> 0.90 mg/dL or > 80 μmol/L
Child	> 0.90 mg/dL or > 80 μmol/L
Adolescent	> 1.30 mg/dL or > 115 μmol/L

#### Blood Urea Nitrogen (BUN)

Measurement	Score = 3
Neonate	> 11.9 mg/dL or > 4.3 mmol/L
All Other Ages	> 14.9 mg/dL or > 5.4 mmol/L

### HEMATOLOGY TESTS (1,2)

#### White Blood Cell Count (cells/mm<sup>3</sup>)

Measurement	Score = 4
All ages	< 3,000

#### Prothrombin Time (PT) or Partial Thromboplastin Time (PTT) (seconds)

Measurement	Score = 3
Neonate	PT > 22.0 or PTT > 85.0
All Other Ages	PT > 22.0 or PTT > 57.0

#### Platelet Count (cells/mm<sup>3</sup>)

Measurement	Score = 2	Score = 4	Score = 5
All ages	100,000-200,000	50,000-99,999	< 50,000

### TOTAL PRISM III SCORE \_\_\_\_\_

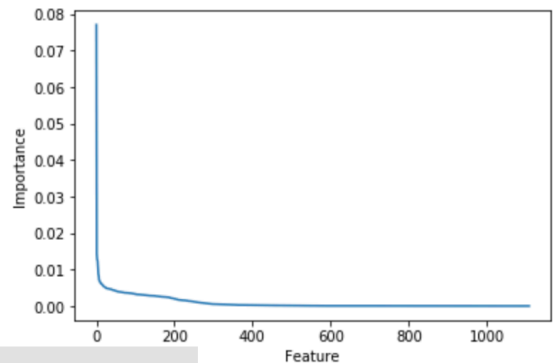
### OTHER FACTORS (10)

☐ Nonoperative CV disease ☐ Chromosomal anomaly ☐ Cancer ☐ Previous PICU admission ☐ Pre-ICU CPR  
☐ Post-operative ☐ Acute diabetes (eg DKA) ☐ Admission from inpatient unit (exclude post-operative patients)

#### Notes:

- PRISM III mortality risk equations are available for the first 12 hours and the first 24 hours of PICU care.
- General: Use the highest and/or the lowest values for scoring. When there are both low and high ranges, PRISM III points may be assigned for the low and the high ranges. Readmissions are included as separate patients. Exclude admissions routinely cared for in other hospital locations, staying in the PICU < 2 hours; and those admitted in continuous CPR who do not achieve stable vital signs for ≥ 2 hours. Deaths occurring in the OR are included only if the operation occurred during the PICU stay and was a therapy for the illness requiring PICU care. Terminally ill patients transferred from the PICU for "comfort care" are included as PICU patients for the 24 hours following PICU discharge or, if receiving technologic support, until 24 hours after the technologic support is discontinued. Ages: Neonate = 0 - < 1 month; Infant = ≥ 1 month - 12 months; Child = ≥ 12 months - 144 months; Adolescent > 144 months.
- Heart Rate: Do not assess during crying or iatrogenic agitation.
- Temperature: Use rectal, oral, blood, or axillary temperatures.
- Pupillary Reflexes: Nonreactive pupils must be > 3 mm. Do not assess after iatrogenic pupillary dilatation.
- Mental Status: Include only patients with known or suspected, acute CNS disease. Do not assess within 2 hours of sedation, paralysis, or anesthesia. If there is constant paralysis and/or sedation, use the time period without sedation, paralysis, or anesthesia closest to the PICU admission for scoring. Stupor/coma is defined as GCS score < 8 or stupor/coma using other mental status scales.
- Acid-Base: Use calculated bicarbonate values from blood gases only if total CO<sub>2</sub> is not measured routinely. pH and PCO<sub>2</sub> may be measured from arterial, capillary, or venous sites.
- PaO<sub>2</sub>: Use arterial measurements only.
- Whole Blood Corrections: Whole blood measurements should be increased as follows: glucose - 10%; sodium - 3 mmol/L; potassium - 0.4 mmol/L. (Pediatric Reference Ranges, Soldin SJ, Hicks JM eds, AACC Press, Washington, D.C., 1995).
- Nonoperative CV disease includes acute cardiac and vascular conditions as the primary reasons for admission. Cancer and chromosomal anomalies are acute or chronic. Previous PICU admission and pre-PICU CPR refer to the current hospital admission. CPR requires cardiac massage. Post-operative is the initial 24 hours following an OR surgical procedure. Catheterizations are not post-operative. Acute diabetes includes acute manifestation of diabetes (e.g. DKA) as the primary reason for PICU admission. Admission from routine care area includes all inpatient locations except the operating or recovery rooms.

# Results: Feature Importance from RF



排序

	col	score	missing_rate	
1	age_month	0.076988	0.000000	年龄（月）
2	lab_5211_min	0.014178	0.345676	实际碱剩余
3	lab_5227_max	0.012710	0.349543	乳酸
4	lab_5249_min	0.012440	0.345899	标准碱剩余
5	lab_5235_max	0.010811	0.345156	二氧化碳分压
6	lab_5227_min	0.008779	0.349543	乳酸
7	lab_5237_min	0.008283	0.345379	酸碱度
8	lab_5248_min	0.007060	0.345528	标准碳酸氢根
9	chart_1016_min	0.006939	0.399435	收缩压
10	lab_5223_max	0.006678	0.365752	血糖
11	chart_1001_min	0.006429	0.327385	体温
12	lab_5226_max	0.006284	0.345081	钾
13	lab_5211_max	0.006113	0.345676	实际碱剩余
14	chart_1001_max	0.006089	0.327385	体温
15	chart_1004_min	0.006066	0.327236	呼吸
16	lab_5249_max	0.005871	0.345899	标准碱剩余

17	chart_1004_max	0.005618	0.327236	呼吸
18	lab_5233_max	0.005549	0.842665	p50(T)
19	chart_1016_max	0.005463	0.399435	收缩压
20	lab_5224_min	0.005411	0.345304	碳酸氢根HCO3-
21	chart_1015_min	0.005297	0.399435	舒张压
22	lab_5218_min	0.005160	0.345081	氯 Cl-
23	lab_5236_max	0.005128	0.842442	二氧化碳分压 pCO2(T)
24	lab_5252_min	0.005066	0.345453	氧饱和度 sO2
25	lab_5174_min	0.005026	0.383077	INR(PT)
26	lab_5215_max	0.004970	0.345230	钙（离子） Ca2+
27	lab_5186_max	0.004826	0.383077	凝血酶原时间(PT)
28	lab_5127_max	0.004813	0.167819	血小板压积
29	lab_5129_max	0.004811	0.148189	血小板计数
30	lab_5213_max	0.004808	0.827496	阴离子间隙 Anion Gap(K+)
31	lab_5239_min	0.004796	0.345156	氧分压 pO2
32	lab_5186_min	0.004768	0.383077	凝血酶原时间(PT)

# Results: Compare

AUROC (mean, std)

#Features	defined by model	all	128	64	32	16	8	4
PRISM_III	0.5949, 0.0000							
LR		0.7100, 0.0157	0.7612, 0.0132	0.7806, 0.0168	0.8054, 0.0090	0.7964, 0.0143	0.6832, 0.0079	0.6552, 0.0128
RF		0.8277, 0.0142	0.8307, 0.0156	0.8232, 0.0076	0.8146, 0.0177	0.7729, 0.0211	0.6649, 0.0198	0.6424, 0.0192

AUPRC (mean, std)

#Features	defined by model	all	128	64	32	16	8	4
PRISM_III	0.1534, 0.0000							
LR		0.1730, 0.0076	0.1958, 0.0219	0.2208, 0.0220	0.3226, 0.0148	0.3129, 0.0142	0.2659, 0.0175	0.2428, 0.0210
RF		0.2930, 0.0095	0.2986, 0.0131	0.2994, 0.0071	0.3045, 0.0115	0.2722, 0.0109	0.2401, 0.0132	0.2029, 0.0208

# Conclusion

- LR and RF can perform better than PRISM\_III
- Feature selection can promote both LR and RF
- RF with 128 features performs the best
- The recommended model is LR with 32 features



# 问题&讨论

- 除了PRISM\_III是否有别的被广泛使用的方法？
- 我查了SAPS II等适用于16岁以上的人，所以就没有对比，是否合理？
- P6是使用随机森林建模全部1109个特征后，得到了最重要的32个特征的排序，请问模型选出的特征是否真的重要？是否有错选？是否有漏选？
- 合适的目标期刊

Thanks!