

Background

Unplanned extubation (UE) reported 0.5% to 35.8% in the literature review. UE is the adverse event in the intensive care unit (ICU) which is related to the patient safety and morbidity. Prevention and early detection of the UEs is important but difficult to predict.

The aim of study is to compare the UE and planned extubation, to identify risk factors for UE, and to develop a machine learning based UE prediction model in the ICU.

Methods

A retrospective study was carried out in the ICU of an academic tertiary hospital. Data were extracted from the Clinical Data Warehouse.

The study included patients who admitted in the ICU between January 1, 2010, and December 31, 2018. During the study period, 102,178 cases were treated in the ICU, 46,018 cases underwent intubation. The include criteria were that the first episode of extubation in the ICU and needing invasive mechanical ventilation for at least 24 hours. Patients aged <18 years were excluded. Among 7,189 include cases, 249 cases underwent UE event.

We used glasgow coma scale (GCS), richmond agitation-sedation scale (RASS), confusion assessment method (CAM) and use of physical restraints as input variables. These variables can be converted to OMOP CDM.

We developed two machine learning algorithm using random forest and support vector machine, respectively.

Results

Table 1. Demographic and Clinical characteristics

Extubation state	Unplanned (N=249)	Planned (N=6,941)	P-value
Sex, N (%)			<0.001
- M	190 (76.3)	4,481 (64.6)	
Age, mean ± SD	62.2 ± 13.8	62.0 ± 15.0	0.871
CPR, N (%)			0.687
- No	240 (96.4)	6,639 (95.6)	
Reason for ICU admission, N(%)			<0.001
- Cardiovascular	41 (16.5)	940 (13.5)	
- Peri operative	38 (15.3)	2,419 (34.9)	
- Respiratory	139 (55.8)	2,578 (37.1)	
- Others	31 (12.4)	1,004 (14.5)	
Intubation site, N (%)			<0.001
- Emergency room	33 (13.3)	631 (9.1)	
- Intensive care unit	176 (70.7)	4,193 (60.4)	
- Operation room	17 (6.8)	1,320 (19.0)	
- Ward, Others	23 (9.2)	797 (11.5)	
Intra-hospital location, N (%)			<0.001
- Emergency room	87 (34.9)	2,034 (29.3)	
- Intensive care unit	35 (14.1)	799 (11.5)	
- Operation room	28 (11.2)	1,976 (28.5)	
- Ward	85 (34.1)	1,432 (20.6)	
- Others	14 (5.6)	700 (10.1)	
In-hospital mortality, N (%)			0.001
- No	150 (60.2)	4,867 (70.1)	
ICU mortality, N (%)			0.002
- No	199 (79.9)	6,032 (86.9)	
Operation, N (%)			<0.001
- No	187 (75.1)	3,721 (53.6)	
Work shift, N (%)			<0.001
- Day	94 (37.8)	4,269 (61.5)	
- Evening	62 (24.9)	2,234 (32.2)	
- Night	93 (37.3)	438 (6.3)	
Mechanical ventilator day, median ± IQR	3.7 ± 2.8	4.6 ± 4.5	<0.001
Hospital days, median ± IQR	41.1 ± 49.1	560.9 ± 13600	0.001
Reintubation within 24hrs, N(%)			<0.001
- No	144 (57.8)	6,328 (91.2)	

During the study period, among the 7,190 cases, 249 underwent UE. The basic patient characteristics are shown in Table 1. Among the unplanned extubation group, 31% underwent reintubation within 1 hour and 55% was within 3 hours. 10% of planned extubation group underwent reintubation within 1 hour.

We developed machine learning prediction algorithm using SVM and random forest. The results of AUROC were 0.817 for SVM and 0.813 for random forest. Figure 2 shows AUROC results.

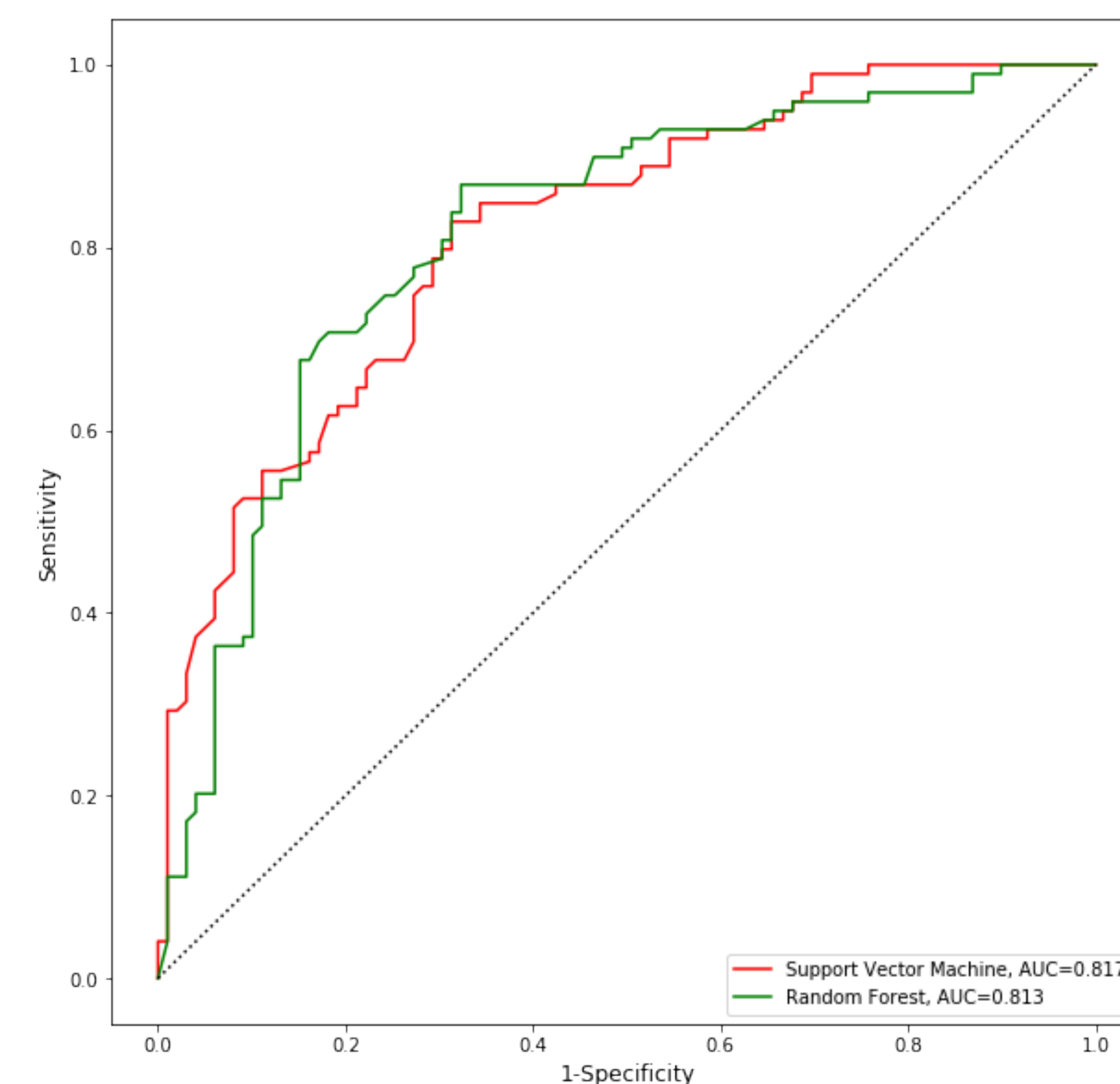


Figure 2. AUROC results

Conclusions

In this study, we development of unplanned extubation prediction model in the ICU and the AUROC was 0.817 and 0.813. Common input variables were used, so this algorithm is suitable for application to other institutions.