Real-time Vasoactive Inotrope Score to Predict Poor Outcome in Pediatric Patients

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BACKGROUND

- The vasoactive-inotrope-score (VIS) has been used to objectively quantify the degree of cardiovascular support in critically ill children
- Previous studies have measured VIS at predetermined time points
- Static measures may not reflect totality of support in ICU stay
- Purpose of our study was to calculate a cumulative VIS in patients admitted to a pediatric ICU to determine if cumulative VIS predicts a complicated ICU course
- Hypothesis: higher cumulative VIS will predict poor outcome in this population

METHODS

- Single center retrospective study of all patients admitted to PICU between 2019-2021 that received vasoactive agents
- Cumulative VIS was calculated using a predetermined algorithm generated from real-time infusion pump data
- Sensitivity analysis was used to determine the most optimal cut-off utilizing Youden's statistic
- Poor outcome was defined a priori as cardiac arrest, ECMO requirement, or mortality

VIS 2020:

10,000 × Vasopressin dose (U/kg/min) +
100 × Epinephrine dose (µg/kg/min) +
100 × Norepinephrine dose (µg/kg/min) +
50 × Levosimendan dose (µg/kg/min) +
25 × Olprinone dose (µg/kg/min) +
20 × Methylene blue dose (mg/kg/h) +
10 × Milrinone dose (µg/kg/min) +
10 × Phenylephrine dose (µg/kg/min) +
10 × Terlipressin dose (µg/min) +
0.25 × Angiotensin II dose (ng/kg/min) +
Dobutamine dose (µg/kg/min) +
Dopamine dose (µg/kg/min) +
Enoximone dose (µg/kg/min)

Figure 1. Vasoactive-inotrope score equation

DATA

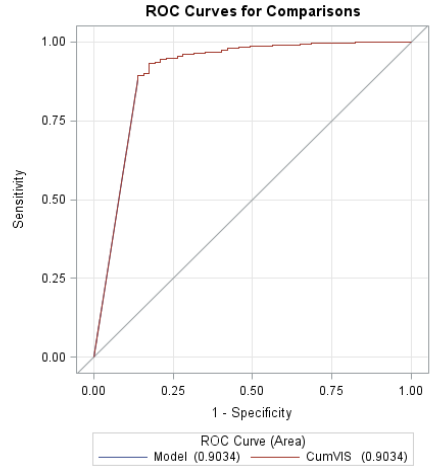
Table 1. Summary statistics for continuous and rank variables stratified by poor outcome status.

	With Poor Outcome	Without Poor Outcome	
	Median [IQR]	Median [IQR]	p-value
AgeMonths	50 [3, 152]	61 [13, 162.5]	0.038
Norepi	1.3 [0, 4.6]	0 [0, 0]	< 0.001
Epi	2.3 [0.2, 5.9]	0 [0, 0]	< 0.001
Milrinone	0 [0, 2.4]	0 [0, 0]	< 0.001
Dopa	0 [0, 0]	0 [0, 0]	< 0.001
Phenyl	0 [0, 0]	0 [0, 0]	< 0.001
Vaso	0 [0, 7.5]	0 [0, 0]	< 0.001
TotVIS6	64.3 [13.1, 162.5]	0 [0, 0]	< 0.001
TotVIS12	141.6 [32.5, 287.1]	0 [0, 0]	< 0.001
TotVIS18	201.3 [56.9, 704.6]	0 [0, 0]	< 0.001
TotVIS24	206.3 [66.2, 990.3]	0 [0, 0]	< 0.001
TotVIS36	335.6 [97.9, 990.3]	0 [0, 0]	< 0.001
TotVIS48	355.3 [105.2, 990.3]	0 [0, 0]	< 0.001
AveVIS6	10.7 [2.2, 27.1]	0 [0, 0]	< 0.001
AveVIS12	11.8 [2.7, 23.9]	0 [0, 0]	< 0.001
AveVIS18	11.2 [3.2, 39.1]	0 [0, 0]	< 0.001
AveVIS24	8.6 [2.8, 41.3]	0 [0, 0]	< 0.001
AveVIS36	9.3 [2.7, 27.5]	0 [0, 0]	< 0.001
AveVIS48	7.4 [2.2, 20.6]	0 [0, 0]	<0.001
CumVIS	806.5 [174.8, 2429.9]	0 [0, 0]	< 0.001
POPCdiff	4 [2, 5]	0 [0, 0]	< 0.001
PCPCdiff	5 [2, 5]	0 [0, 0]	< 0.001
PIM2	-1.9 [-3.3, -0.1]	-4.9 [-6.3, -4.5]	< 0.001
PIM3	-2.4 [-3.5, -0.1]	-5.5 [-6.1, -4.8]	< 0.001
PRISM3	23 [12, 30]	2 [0, 5]	< 0.001
PELOD	32 [21, 42]	1 [0, 10]	< 0.001
LOShours	98 [34, 294]	28 [18, 56]	< 0.001

Table 2. Results of univariate logistic regression with ROC curve analysis

Poor Outcome:	AUC	CI	SE	p-value
AgeMonths	0.58	0.64-0.81	0.04	0.1621
TotVIS6	0.87	0.82-0.92	0.03	< 0.001
TotVIS12	0.89	0.84-0.94	0.02	< 0.001
TotVIS18	0.90	0.85-0.94	0.03	< 0.001
TotVIS24	0.90	0.85-0.94	0.03	< 0.001
TotVIS36	0.90	0.85-0.95	0.03	< 0.001
TotVIS48	0.90	0.85-0.95	0.03	< 0.001
AveVIS6	0.87	0.82-0.92	0.03	< 0.001
AveVIS12	0.89	0.84-0.94	0.02	< 0.001
AveVIS18	0.90	0.85-0.94	0.03	< 0.001
AveVIS24	0.90	0.85-0.94	0.03	< 0.001
AveVIS36	0.90	0.85-0.95	0.03	< 0.001
AveVIS48	0.90	0.85-0.95	0.03	< 0.001
CumVIS	0.9	0.85-0.95	0.03	< 0.001
POPCadmit	0.56	0.49-0.62	0.04	0.0647
PCPCadmit	0.56	0.50-0.63	0.03	0.0621
PIM2	0.92	0.87-0.96	0.02	< 0.001
PIM3	0.92	0.88-0.96	0.02	< 0.001
PRISM3	0.91	0.86-0.96	0.03	< 0.001
PELOD	0.96	0.93-0.98	0.01	< 0.001
LOShours	0.72	0.64-0.81	0.04	< 0.001

Figure 2. ROC curve for cumulative VIS and poor outcome



RESULTS

- Total cumulative VIS had AUC of 0.90
- Sensitivity analysis reveals Youden's index occurs at VIS > 96.8 and reflects the optimal cut-off with sensitivity= 93.1 and specificity= 82.5
- Cumulative VIS performed similar to PIM2, PIM3, and PRISM3 in predicting poor outcome but was outperformed by PELOD

CONCLUSIONS

- Cumulative VIS can be captured in real-time using infusion pump data integrated into the electronic health record
- Based on the ROC curve, cumulative VIS > 96.8 reflects increased probability of worse outcome
- Integration of cumulative VIS into real-time alert system could give clinicians more data for patient management and increase situational awareness
- Multicenter evaluation is needed to evaluate if cumulative VIS maintains its superiority in predicting poor outcomes