Evaluation of predicting performance of POSITIVE, PREDICT and VIRSTA score for Infective Endocarditis in patients with Staphylococcus aureus bacteremia

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Background

Prompt identification of Infective Endocarditis (IE) in patients with Staphylococcus aureus bacteremia (SAB) is important as delayed diagnosis results in 15-20% increased mortality. Predictive clinical scoring strategies have been developed to optimize the diagnostic process, particularly the use of invasive methods such as Transesophageal Echocardiography(TEE), known to be superior to Transthoracic Echocardiography. However, the eligibility of TEE is challenged by the nature of its invasiveness in critically ill patients and in those with multiple comorbidities.

Three scoring systems have been proposed to predict the risk of IE: VIRSTA, PREDICT and POSITIVE. We compared these scoring strategies in combination with other clinical data to test the hypothesis that inclusion of time to blood culture positivity(TTP) in the scoring strategies might improve the sensitivity and specificity of clinical risk stratification.

VIRSTA *Cutoff: ≥3*

Variables	Points assigned
Cerebral or peripheral emboli	5
Meningitis	5
Permanent intracardiac device	4
Previous IE	4
Intravenous drug use	4
Pre-existing native valve disease	3
Persistent bacteremia *	3
Vertebral Osteomyelitis	2
Community or non-nosocomial health care associated acquisition	2
Severe sepsis or shock	1
C-reactive protein > 190 mg/L	1

* Defined as positive follow up blood cultures obtain 48hr after initial positive blood culture

POSITIVE *Cutoff: >4*

Variables	Points assigned
TTP < 9 h	5
TTP 9-11 h	3
TTP 11-13h	2
Intravenous drug use	3
Vascular phenomena	6
Predisposing heart disease	5

PREDICT DAY 5 *Cutoff: ≥2*

Variables	Points assigned
Permanent Pacemaker	3
Implantable cardioverter defibrillator	2
Community acquisition	2
Healthcare acquisition	1
Positive culture after ≥ 72 h	2

Materials and Methods

Adults (≥ 18y) with SAB admitted to Ochsner LSU Health Shreveport in 2020-2021 were retrospectively screened. Patients with polymicrobial bacteremia, with index blood cultures obtained at a different institution and without cardiac imaging were excluded.

In this preliminary analysis, 56 patients (26 with and 30 without IE) were studied.

- IE was defined as patients who met modified Dukes criteria for definite IE.
- The three scores were calculated for each subject.
- TTP, defined as the time from incubation to automated detection, was obtained from the microbiology laboratory.
- Clinical predictors of IE were identified using multivariable logistic regression analysis.

Results

Table 1: Baseline characteristics

	Total (n = 56)	IE (n = 26)	No IE (n = 30)	p value
Age	56	54.7	57.4	0.46
Male	60.7% (34)	57.69% (15)	63.33% (19)	0.88
BMI	27.64	23.9	31.4	0.32
Race				0.59
Caucasian	37.5% (21)	30.76% (8)	43.3% (13)	
African American	57.14% (32)	61.54% (16)	53.3% (16)	
Hispanic	3.57% (2)	3.85% (1)	3.33% (1)	
Asian	1.79% (1)	3.85% (1)	0	
Comorbidities				
CAD	35.71 (20)	42.3% (11)	30% (9)	0.49
Cirrhosis	7.1% (4)	11.53% (3)	3.33% (1)	0.5
CKD	32.1% (18)	38.4% (10)	26.67% (8)	0.51
Connective tissue disorder	8.9% (5)	11.54% (3)	6.67% (2)	0.87
COPD	25% (14)	26.92% (7)	23.33% (7)	1
CHF	42.9% (24)	50% (13)	36.67% (11)	0.46
Dementia	8.9% (5)	15.38% (4)	3.33% (1)	0.27
Diabetes	50% (28)	42.3% (11)	56.67% (17)	0.42
HIV	3.6% (2)	3.85% (1)	3.33% (1)	1
Solid Tumor	14.3% (8)	15.38% (4)	13.33% (4)	1
Hematopoietic malignancy	5.4% (3)	0	10% (3)	0.288
Stroke	21.4% (12)	26.9% (7)	16.67% (5)	0.54
Obesity	33.9% (19)	23.08% (6)	43.3% (13)	0.19
Other	23.2% (13)	11.54% (3)	33.33% (10)	0.1
Charlson Comorbidity Index	4	4	4	0.49
Hemodialysis on admission	19.6% (11)	26.9% (7)	13.33% (4)	0.35
Immunocompromised	39.29% (22)	50% (13)	30% (9)	0.16
Presentation with acute cardio/cerebro vascular accident	17.9% (10)	30.76% (8)	6.67% (2)	0.0456
Site of infection				
Endophthalmitis	1.79% (1)	0	0	0.94
Osteomyelitis	8.9% (5)	7.69% (2)	10% (3)	1
Septic arthritis	7.1% (4)	0	13.33% (4)	0.158
Epidural abscess	3.6% (2)	7.69% (2)	0	0.41
Meningitis	1.8% (1)	3.85% (1)	0	0.94
Cellulitis	14.3% (8)	7.69% (2)	20% (6)	0.35
Pneumonia	16.1% (9)	7.69% (2)	23.33% (7)	0.22
Skin and soft tissue infections	32.1% (18)	50% (13)	16.67% (5)	0.02
Other (none apparent)	21.4% (12)	15.38% (4)	26.67% (8)	0.48
Predisposing condition				
IV drug use	12.5% (7)	19.2% (5)	6.67% (2)	0.31
Cardiac device	8.9% (5)	3.85% (1)	13.33% (4)	0.44
Pacemaker	3.57% (2)	3.85% (1)	3.33% (1)	1
AICD	7.1% (4)	0	13.33% (4)	0.16
Type of valve	10.7% (6)	19.2% (5)	3.33% (1)	0.14
Bioprosthetic heart valve	7.1% (4)	11.54% (3)	3.33% (1)	0.5
Mechanical heart valve	3.6% (2)	7.69% (2)	0	0.41
History of repaired native valve	5.4% (3)	3.85% (1)	6.67% (2)	1
Previous Endocarditis	1.79% (1)	3.85% (1)	0	0.94
Procedure or Invasive surgery ≤ 30 days	32.1% (18)	30.76% (8)	33.33% (10)	1
Osteomyelitis	8.9% (5)	7.69% (2)	10% (3)	1
Septic arthritis	7.1% (4)	0	13.33% (4)	0.16
Central lines	23.2% (13)	23.08% (6)	23.33% (7)	1
AVF	19.6% (11)	26.92% (7)	13.33% (4)	0.35
None apparent	25% (14)	15.38% (4)	33.33% (10)	0.21
Source (Endovascular)	58.9% (33)	76.92% (20)	43.3% (13)	0.02
SAB onset				0.28
Community	35.71% (20)	26.9% (7)	43.3% (13)	
Healthcare	39.29% (22)	50% (13)	30% (9)	
Nosocomial	25% (14)	23.08% (6)	26.67% (8)	
PITT bacteremia score	3	2	3	0.81
MSSA (organism isolated)	62.5% (30)	57.69% (15)	66/67% (20)	0.68
Time to blood culture positivity (hours)	10.65	9.65	11	0.12
Duration of bacteremia (days)	5.2	5.65	3.7	0.09
Persistent bacteremia (≥ 72 hours)	58.9% (33)	61.54% (16)	56.67% (17)	0.92
TTE	100% (56)	100% (26)	100% (30)	1
TEE	62.5% (30)	69.23% (18)	56.67% (17)	0.49
CTA/Cardiac MRI	12.5% (7)	23.08% (6)	3.33% (1)	0.06
ID consult	71.4% (40)	92.31 (24)	53.3% (16)	0.003
Mortality				
In hospital	19.6% (11)	19.2% (5)	20% (6)	1
30 day	17.9% (10)	26.92% (7)	10% (3)	0.18
Relapse	10.7% (6)	15.38% (4)	6.67% (2)	0.54

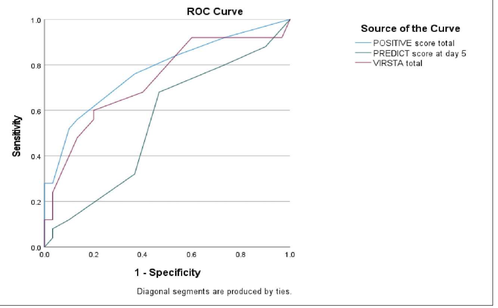
Results

- The demographic, baseline characteristics and mode of presentation, was no different in both groups based on analysis of >50 factors (Table 1)
- The mean TTP for subjects with and without IE were no different (9.65h vs 11h, p=0.12)
- TTP≤13h as an independent variable was found to be sensitive but not specific.
- VIRSTA was found to be the most sensitive scoring method. POSITIVE, which includes TTP as a component, was the most accurate, but least sensitive method.
- Addition of TTP≤13h to VIRSTA and PREDICT increased sensitivity but lowered specificity.

Table 2: Predicting Performance of Clinical scores and Time to Blood Culture Positivity

	Sensitivity % (95% CI)	Specificity % (95% CI)	PPV % (95% CI)	NPV % (95% CI)	LR+ (95% CI)	LR- (95% CI)	Accuracy % (95% CI)	AUC
VIRSTA	88.46 (76.18-100)	23.33 (8.2-38.47)	50 (35.55-64.45)	70 (41.60-98.40)	1.154 (0.87-1.43)	0.495 (-0.12-1.11)	53.57 (40.51-66.63)	0.732
PREDICT	76.92 (60.73-93.12)	30 (13.60-46.40)	48.78 (33.48-64.08)	60 (35.21-84.79)	1.099 (0.75-1.45)	0.76 (0.08-1.45)	51.79 (38.70-64.87)	0.547
POSITIVE	69.23 (51.49-86.97)	63.33 (46.09-80.58)	62.069 (44.41-79.73)	70.37 (53.15-87.59)	1.888 (0.88-2.89)	0.4858 (0.18-0.80)	68.33 (53.67-78.47)	0.773
TTP ≤13	80.77 (65.62-95.92)	30 (13.60-46.40)	50 (34.88-65.12)	64.29 (39.19-89.38)	1.15 (0.81-1.50)	0.641 (0.03-1.26)	53.57 (40.51-66.63)	0.58
VIRSTA + TTP ≤13	96.15 (88.76-100)	10 (0-20.74)	48.08 (34.50-61.66)	75 (32.57-100%)	1.07 (0.92-1.22)	0.38 (-0.46-1.23)	50 (36.90-63.10)	
PREDICT + TTP ≤13	88.46 (76.18-100)	10 (0-20.74)	46 (32.19-59.81)	50 (9.99-90)	0.98 (0.8-1.16)	1.15 (-0.6-2.90)	46.43 (33.37-59.49)	

Figure 1: Receiver Operating Characteristic Curves of VIRSTA, PREDICT, POSITIVE scores



Conclusions

- While the sensitivity of scoring strategies is acceptable, none of the proposed methods has adequate specificity.
- Inclusion of TTP increases the sensitivity of the scores
- Larger studies are needed for the development of a highly specific and accurate scoring method that includes classic risk factors and TTP.

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