Procalcitonin as a Predictor of Bacteremia in Children with Intestinal Failure Presenting with Fever

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Background

- Children with intestinal failure are at high risk of central-line associated bloodstream infections (CLABSIs)[1, 2, 3]
- Children are often admitted even if the concern for CLABSI is low[4]
- Procalcitonin (PCT) emerging as an important serum biomarker for bacterial infection[5, 6]

Objective

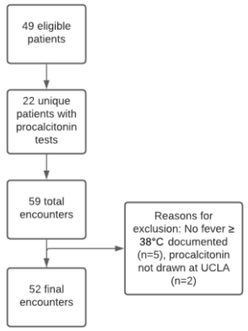
The objective of this study is to investigate the association between PCT and bacteremia in children with intestinal failure and to determine if there is a best threshold value for PCT that can predict bacteremia.

Aims

- Collect PCT levels in children with intestinal failure and total parenteral nutrition (TPN) dependence that present with fever
- Correlate PCT levels with documented bacteremia

Methods

- Retrospective cohort study on children with intestinal failure, central venous catheters and TPN Dependence
- Inclusion criteria:
  - 1 month to 21 years old
  - January 2015 to December 2020
  - Presenting to Emergency Room with temperature ≥38°C
  - Blood cultures and PCT levels drawn within 48 hours of presentation
  - No other identifiable source of bacterial infection



Data Collection & Statistical Analysis

- Patient demographics, hospitalization data, clinical characteristics, inflammatory markers and microbiological data were collected
  - Clinical characteristics compared with Fischer's exact test
  - Inflammatory markers compared with Wilcoxon rank sum test
- Receiver operating characteristic (ROC) curve was created for bacteremia using PCT levels
- Area under the curve (AUC) was calculated
- Youden's Index was used to find the PCT level that maximized sensitivity and specificity

Results

Table 1. Patient Demographics and Hospitalization Data Overall and by Blood Culture Status

	Overall	Nonbacteremic	Bacteremic	*p*
Patients, *n*	22			
Bacterial cultures (%)	52	19 (36.5)	33 (63.5)	
Age in months*	122 ± 66	94.7 ± 55.1	122.6 ± 69.6	0.117
Sex, *n* (%)				0.774
Female	25 (48.1)	10 (52.6)	15 (45.5)	
Male	27 (51.9)	9 (47.4)	18 (54.5)	
Race, *n* (%)				0.27
White	10 (19.2)	3 (15.8)	7 (21.2)	
Black	19 (36.5)	5 (26.3)	14 (42.4)	
Hispanic	21 (40.4)	11 (57.9)	10 (30.3)	
Other	2 (3.8)		2 (6.1)	
Post-small bowel transplant, *n* (%)	10 (45.4)	3 (15.8)	7 (21.1)	0.728
Admit Service, *n* (%)				0.363
Ward	44 (84.6)	18 (95.2)	26 (78.8)	
ICU	8 (15.4)	1 (5.3)	7 (21.2)	
Length of stays*	7.48 ± 4.68	5.05 ± 3.57	8.88 ± 4.71	*0.001*

*Data represented as mean ± SD. Continuous and categorical data compared with Fischer's exact test.

Table 2. Clinical Characteristics on Admission Overall and by Blood Culture Status

	Overall (N=52)	Nonbacteremic (N=19)	Bacteremic (N=33)	*p*
Temperature in Celsius*	38.8 ± 0.7	38.6 ± 0.2	38.8 ± 0.1	0.404
Heart Rate*	126 ± 28	121 ± 6	128.5 ± 4.5	0.33
Respiratory Rate*	25.6 ± 9.1	22.6 ±1.9	27.3 ±1.5	0.063
Systemic Blood Pressure*	108 ± 16	110.4 ± 3.8	107.1 ± 2.8	0.491
Diastolic Blood Pressure*	66.6 ± 13.9	69.4 ± 3.3	65.0 ± 2.5	0.286
SIRS criteria met, *n* (%)*				*0.007*
No	7 (13.5)	6 (31.6)	1 (3)	
Yes	45 (86.5)	13 (68.4)	32 (97)	
White blood count (x 10E3/mL)◆	6.77 [4.4-9.9]	6.31 [4.2-9.9]	7.24 [4.5-9.9]	0.916
C-reactive protein (mg/dL), (*n*)◆	(14) 5.35 [1-7.4]	(1) 0.70 [0.7]	(13) 6.5 [1.2-7.4]	—
Lactate (mg/dL), (*n*)◆	(46) 14 [11-26]	(16) 11 [9-13]	(30) 21 [14-31]	*<0.001*
Procalcitonin (µg/L)◆	0.6 [0.2-5.3]	0.16 [0.1-0.24]	3.2 [0.9-15.5]	*<0.001*

*Vital signs are presented as mean ± SD. Vital signs are compared with Fischer's exact test. *SIRS criteria met if ≥2 parameters met, 1 of which was abnormal temperature ≥38°C or leukocyte count including tachycardia or bradycardia per age, tachypnea per age or mechanical ventilation, abnormal leukocyte count per age. ◆Inflammatory markers are expressed as median [IQR]. Inflammatory markers are compared with Wilcoxon rank sum test. Of note, there were not enough C-reactive protein levels for comparison.

- Median PCT levels were 3.2 (IQR 1-16) and 0.16 (IQR 0.1-0.2) in positive and negative blood cultures, respectively
- PCT level was higher in Gram-Negative bacteremia with a median PCT level of 15.5 µg/L (IQR 3-29) versus Gram-Positive bacteremia with a level of 0.4 µg/L (IQR 0.2-2), p=<0.001
- AUC for positive blood culture was 0.96
- A PCT level of 0.38 µg/L has a sensitivity of 0.94 and specificity of 0.89
- The negative predictive value of PCT was 0.89 and positive predictive value was 0.72

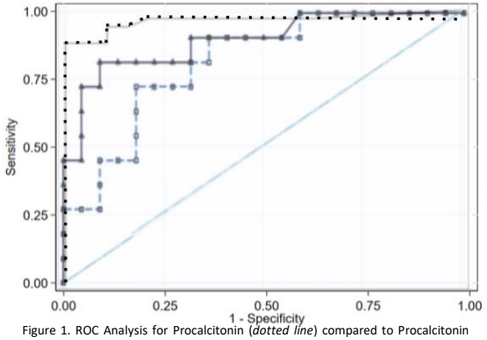


Figure 1. ROC Analysis for Procalcitonin (*dotted line*) compared to Procalcitonin (*solid line*) ROC analysis for predicting bacterial infections in adult ICU and C-reactive protein (*dashed line*) in Cuquemelle, et al. (2011)[7]

Table 3. Infectious Etiologies

Bacteremia Etiologies	N = 33 (%)
Enterobacter spp.	3 (5.77)
Escherichia coli	3 (5.77)
Klebsiella pneumoniae	1 (1.92)
Micrococcus spp.	1 (1.92)
Pseudomonas spp.	1 (1.92)
Staphylococci spp.	
S. epidermidis	8 (15.38)
S. aureus	4 (7.69)
S. hominis	1 (1.92)
Polymicrobial	11 (21.15)
Other Etiologies	**N = 19 (%)**
Upper respiratory infection	8 (15.38)
Urinary Tract Infection	2 (3.85)
Pneumonia	1 (1.92)
Acute gastroenteritis	1 (1.92)
Herpes Simplex Virus infection	1 (1.92)
Fungal infection	1 (1.92)
Unknown	5 (9.62)

Conclusions

- PCT has a predictive value for bacteremia in our population, especially in combination with clinical judgment
- Given risk of morbidity with CLABSIs is high, PCT should be used with other tools that assess for sepsis such as SIRS criteria
- PCT is significantly higher in gram-negative bacteremia

Next Steps

- Confirm findings in a broader population with more consistent PCT collection
- Compare PCT levels in this population with other serious bacterial infections
- Consider assessing PCT levels when population is clinically well
- Additional studies could assess whether PCT levels can be used to reduce antibiotic use, decrease hospitalizations or reduce costs

Acknowledgements and References

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