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Serum Calprotectin as a Predictive Marker for Late-Onset Sepsis in Preterm Neonates

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Abstract

Background: Globally, neonatal sepsis is a prominent cause of death, particularly among preterm infants. Since sepsis biomarkers sensitivity in preterm neonates, predicting the risk of sepsis still not have been identified. So, there is a need to estimate the efficacy of multiple new biomarkers.

Aim of Study: To estimate the efficacy of serum calprotectin in the first 2 days of life as a predictive marker for late onset sepsis in preterm neonates.

Patients and Methods: The type of the research was prospective cohort research, performed on 40 preterm neonates without clinical and laboratory evidence of sepsis admitted at Neonatal Intensive Care Unit of Children's Hospital of Ain Shams University throughout the duration from January to June 2023 in their first 2 days of life with following-up of these neonates to differentiate septic and non-septic ones later on, The Research Ethics Committee approved the study, the approval number was MS 587/2022.

Results: Septic neonates had statistically significant lower serum calportectin level during their first 2 days of life and ROC Curve demonstrated that cutoff level of serum calportectin that predict neonatal late onset sepsis was ≤114.2ng/ml with sensitivity & specificity of 100% for each and Area Under Curve (AUC) of 1,000.

Conclusion: Serum calportectin level could be used as an early promising biomarker to predict late onset neonatal sepsis.

Key Words: *Calprotectin – Preterm neonates.*

Introduction

CALPROTECTIN consists of two calcium-binding proteins, it is one of the S100 protein family **[1].** After host-pathogen interaction, innate immunity cells released serum calprotectin which is easily detectable in body fluids by Enzyme-Linked Immunosorbent Assay (ELISA) technique **[2].**

Serum calprotectin regulates the activity in inflammatory reactions through its impact on survival and growth of cells sharing in inflammatory processes and a higher level of calprotectin existed in body fluids during certain inflammatory diseases, for example, Rheumatoid arthritis & Cystic fibrosis **[1].**

The identification of serum calprotectin as a crucial regulator of neonatal immunity against sepsis and the observation that its concentration increases physiologically after birth implies that a deficiency in this protein at birth in neonates is correlated with an elevated risk of sepsis **[3].**

Aim of the work:

To estimate the efficacy of serum calprotectin in the first 2 days of life as a predictive marker for late onset sepsis in preterm neonates.

Patients and Methods

Inclusion criteria: Preterm neonates with gestational age thirty four weeks' or less in their first two days of life. Presenting with no clinical signs of sepsis and negative C-reactive protein level.

Exclusion criteria: Neonates with major congenital malformation, inborn error of metabolism (IEM) and perinatal Asphyxia, neonates born to mothers with Chorioamnionitis or premature rupture of membrane (up to 18 hours) and neonates with clinical and laboratory evidence of early onset sepsis.

Methods:

Every neonate who was enrolled underwent full history taking, complete clinical examination, full

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laboratory investigations & received our routine neonatal care.

History taking: Antenatal history including date of 1st day of last menstrual period, antenatal history of mothers with premature rupture of membrane more than 18 hours and chorioamnionitis. Natal history including mode of delivery, with recorded APGAR score at 1 and 5 minutes. Postnatal history including postnatal age at NICU admission, central access insertion and indication for ventilatory support.

Complete clinical examination: Determination of birth weight, sex and gestational age by using Modified Ballard score [4]. Vital signs (Respiratory Rate, Heart Rate, Blood pressure & Temperature), Capillary refill time (CRT), Urine Output (UOP) and Oxygen saturation by pulse oximetry with full chest, heart, abdominal and neurological examinations.

Laboratory investigations: Complete blood picture with differential by using (Derui BCC-3600), C-reactive protein by using (ERM®-DA474/IFCC India), were withdrawn on admission and after 4 and 7 days from admission. Venous blood gases to detect metabolic acidosis by using (TypenexTM TypesafeTM 2.0 Segment Piercing Device). Blood culture was withdrawn on admission then panel of cultures including blood, central line, urine and cerebrospinal with any suspicious attack of late-onset sepsis or increasing CRP.

Calprotectin testing was done by withdrawal of 1ml venous sample throughout the first two days of life of enrolled neonates by using (CalprolabTM Calprotectin ELISA, Calpro AS, Norway) following the manufacturer's instruction [6].

Neonates were identified as having late onset sepsis according to criteria of Tollner and hematological scoring system of Rodwell [7,8].

In this scoring method, each of the seven hematological findings is given a value of one. These findings include the total white blood cell count, the total polymorph nuclear (PMN) count, the immature PMN count, the immature/total PMN ratio, the immature/mature PMN ratio, the platelet count and the degenerative abnormalities in neutrophils. An exception exists in which a score of two is ascribed to an abnormal total polymorph nuclear (PMN) count, rather than one, in the case of a blood smear containing fewer mature PMNs. Thus, the total score ranges from zero to eight and it has been hypothesized that sepsis is extremely unlikely if the score is less than two and extremely probable if it exceeds five.

Assay principle:

After pre-coating the plate with Human CAL antibody, biotinylated Human CAL antibody was added and binded to the antibodies deposited on the wells; finally, streptavidin-horseradish peroxidase (HRP) was added and it binded to the biotinylated CAL antibody.

Table (1): Tollner's score [7].

Parameter	Score
Skin coloration:	
Normal	0
Moderate change	2
Considerable change	4
Microcirculation:	
Normal	0
Impaired	2
Considerably impaired	3
Metabolic acidosis:	
Normal	0
pH ≥7.2	1
pH <7.2	2
Muscular hypotonic:	
No	0
Hypotonic	1
Floppy	2
Bradycardias:	
No	0
Yes	1
Apneic spells:	
No	0
Yes	1
Respiratory distress:	
No	0
Yes	2
Liver enlargement:	
0-2cm	0
2-4cm	0.5
>4cm	1
Gastrointestinal symptoms:	
No	0
Yes	1
White blood cell count:	
Normal	0
Leukocytosis	1
Leukocytopenia	2
Shift to the left:	
No	0
Moderate	2
Considerable	3
Thrombocytopenia:	
No	0
Yes	2

0-4.5: No sepsis.
5-10 : Suspected sepsis.
> 10 : Sepsis.

Table (2): Hematological Scoring System (HSS) of Rodwell **[7]**.

Variables	Score
Enhanced neutrophil IT ratio greater than 0.2	1
Enhanced (PMN) count (greater than 5,400/mm^3) or diminished (less than 1,800/mm^3)	1
An immature to mature neutrophil (IM) ratio greater than or equal to 0.3	1
Count of immature PMNs exceeding 500/mm^3	1
No neutrophils	2
Low leukocyte count (≤ 5,000/mm^3) or high leukocyte count (≥ 30,000/mm^3)	1
PMN degeneration (vacuolization, Dohle bodies, and toxic granules)	1
Decreased of thrombocyte count ≤ 150,000/mm^3	1

IT : Immature to total.
PMN: Polymorph nuclear.

Unbound Streptavidin-HRP was eliminated throughout the washing phase after incubation. Following the addition of the substrate solution, coloration occurred proportionally to the quantity of human CAL. Absorption was measured at 450 nanometer after the reaction was terminated with the addition of an acidic stop solution. The serum was allowed to coagulate for ten to twenty minutes at room temperature before being centrifuged at 2000-3000 the revolutions per minute for twenty minutes. The supernatant was gathered without sediment.

Calculation of Results:

Determine a best fit curve using the data points on the graph & the mean optical density for each standard along the vertical (Y) axis to construct a standard curve. Calculating curve-fitting software is optimal for performing these calculations, & regression analysis can be used to determine the best-fitting line.

Sample size justification:

40 neonates were calculated due to a random sample of at least 38 cases with expected 27 subjects from the positive cases produces a two-sided 95.0% confidence interval with a width of 0.400 when the sample AUC is 0.610.

Ethical considerations:

All information was safeguarded with secret codes and private files and it was only with the consent of parents or legal guardians that information was utilized for medical research.

Statistical analysis:

Version 27 of the Statistical Package for the Social Sciences (IBM SPSS) was utilized to collect and analyze the data. In the case of parametric distributions, quantitative data were displayed as means & standard deviations; for nonparametric distributions, the median, (interquartile range) and for qualitative variables, numbers and percentages were utilized. When the expected count in any cell was less than five, differences in qualitative variables were estimated using the chi-square or Fisher exact test. Paired *t*-tests were utilized to compare two dependent parametric quantitative variables, whereas Mann-Whitney tests were applied to non-parametric distributions. Spearman's correlation analysis was employed to determine the correlation. An analysis of the receiver-operating characteristics (ROC) was conducted on the cut-off values. It was determined that the *p*-value was significant as follows: *p*-value greater than 0.05: non-significant (NS); *p*-value less than 0.05 indicates significant (S); A *p*-value less than 0.01 indicates high significant (HS).

Results

A total of 40 neonates were enrolled in this research, 33 neonates were diagnosed as having late onset sepsis.

The figure showed that serum calprotectin withdrawn in the first 2 days of life was statistically significantly lower in preterm neonates who developed sepsis compared to those who didn't develop sepsis.

Table (3): Demographic characteristics of the studied neonates.

	Non-septic	Septic	Test value	*p*-value
	No. = 7 Patients	No. = 33 Patients		
Gestational age (Weeks):				
Mean ± SD	34.00±0.00	31.36±1.65	4.172•	0.000
Range	34-34	28-34		
Weight (gm):				
Mean ± SD	2221.43±134.96	1520.91±430.61	4.221•	0.000
Range	2000-2400	900-2450		
Mode of delivery, n (%):				
CS	7 (100.0%)	25 (75.8%)	2.121*	0.145
NVD	0 (0.0%)	8 (24.2%)		
Sex, n (%):				
Female	5 (71.4%)	14 (42.4%)	1.948*	0.163
Male	2 (28.6%)	19 (57.6%)		
APGAR at 1min:				
Median (IQR)	7 (6-8)	6 (5-7)	–2.253#	0.024
Range	6-8	4-8		
APGAR at 5min:				
Median (IQR)	9 (8-9)	8 (7-9)	–1.462#	0.144
Range	8-10	6-10		
Need for ventilator support, n (%):				
Noninvasive	7 (100.0%)	12 (36.4%)	9.378*	0.002
Invasive	0 (0.0%)	21 (63.6%)		
Central line insertion, n (%)	2 (28.6%)	29 (87.9%)	11.649*	0.001
Types of Central line, n (%):				
UVC	2 (100.0%)	12 (41.4%)	2.596*	0.107
CVL	0 (0.0%)	17 (58.6%)		
Postnatal age at NICU admission in hours:				
Mean ± SD	2.71±0.76	2.64±0.93	0.207•	0.837
Range	2-4	1-5		
Duration of hospitalization (Days):				
Median (IQR)	7 (7-10)	18 (14-26)	–3.639#	0.000
Range	6-11	6-33		
Mortality, n (%):				
Died	0 (0.0%)	6 (18.2%)	1.497*	0.221

NICU : Neonatal Intensive Care Unit.
CS : Cesarean Section.
NVD : Normal Vaginal Delivery.
UVC : Umbilical Venous Catheter.
CVL : Central Venous Line.

Table (4): Laboratory investigations of the studied neonates.

	Non-septic	Septic	Test value	*p*-value
	No. = 7	No. = 33		
On admission:				
Hb (g/dl):				
Mean ± SD	15.43±0.93	17.02±1.14	–3.460•	0.001
Range	14.2-16.4	14.6-19		
HCT (%):				
Mean ± SD	48.03±3.73	54.35±6.53	–2.462•	0.018
Range	42.2-53	35.1-68		
PLT ($x10^9$/L):				
Mean ± SD	324.29±67.36	348.00±74.54	–0.776•	0.443
Range	228-416	180-465		
TLC ($x10^9$/L):				
Mean ± SD	10.9 (8.7-12.6)	10.6 (9.3-11.3)	–0.855#	0.392
Range	8.6-13.8	7.6-12.9		
CRP (mg/L):				
Median (IQR)	6 (4-6)	6 (6-6)	–0.368#	0.713
Range	4-6	2-6		
After 4 days of admission:				
Hb (g/dl):				
Mean ± SD	14.67±0.73	15.14±1.61	–0.747•	0.460
Range	13.6-15.7	10.4-17.4		
HCT (%):				
Mean ± SD	44.71±3.95	46.51±7.10	–0.643•	0.524
Range	38.1-50	25.2-56.3		
PLT ($x10^9$/L):				
Mean ± SD	273.86±70.45	229.21±99.69	1.121•	0.269
Range	180-365	50-528		
TLC ($x10^9$/L):				
Median (IQR)	11.5 (10.5-11.8)	13.9 (4.6-20.3)	–0.125#	0.901
Range	9.8-12.4	3.4-24.9		
CRP (mg/L):				
Median (IQR)	6 (4-6)	84 (54-96)	–4.122#	0.000
Range	4-6	16-120		
After 7 days of admission:				
Hb (g/dl):				
Mean ± SD	14.08±0.37	13.82±1.49	0.386•	0.702
Range	13.6-14.6	9-15.7		
HCT (%):				
Mean ± SD	42.50±3.20	40.56±5.83	0.720•	0.476
Range	38-46	28-49.6		
PLT ($x10^9$/L):				
Mean ± SD	247.60±52.50	163.76±78.38	2.301•	0.027
Range	190-298	40-360		
TLC ($x10^9$/L):				
Median (IQR)	11.6 (11.5-12.4)	10.3 (6.9-16.7)	–0.173#	0.863
Range	10.8-13.1	3.2-19.8		
CRP (mg/L):				
Median (IQR)	6 (6-6)	48 (36-60)	–3.922#	0.000
Range	4-6	6-98		

Hb : Hemoglobin.
HCT: Hematocrit.
PLT : Platelets.
TLC: Total leucocyte count.
CRP: C-reactive protein

Table (5): Comparison between non septic and septic cases regarding calprotectin level and its age of sampling.

	Non septic	Septic	Test value	*p*-value
	No. = 7	No. = 33		
Age of sampling of calprotectin level, (hours):				
Mean ± SD	32.57±8.70	30.64±8.96	0.522•	0.605
Range	24-48	12-48		
Calprotectin (ng/ml):				
Median (IQR)	327.9 (309.4-383.4)	18.88 (15.49-23.85)	–4.111≠	0.000
Range	301.2-507.6	8.27-114.2		

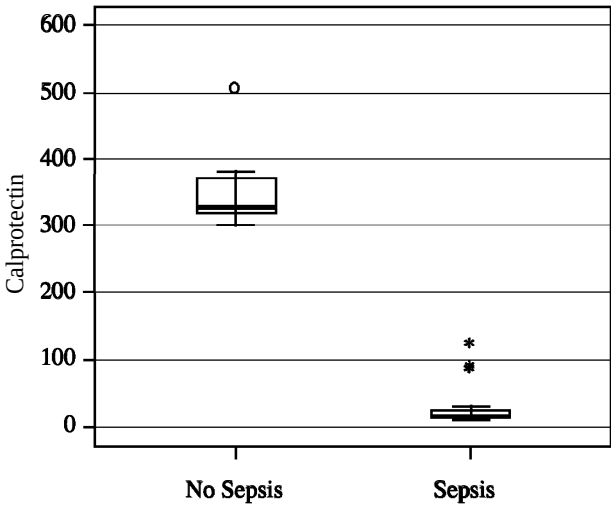
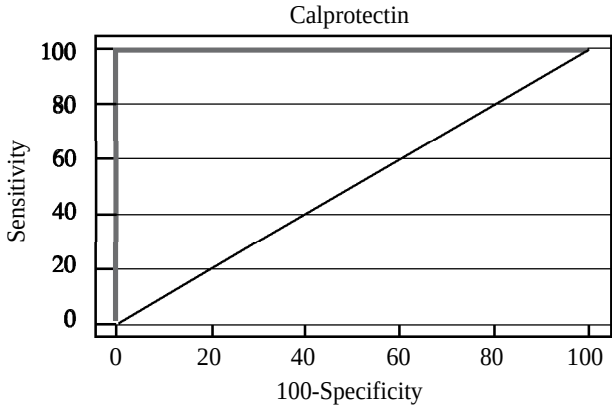


Fig. (1): Comparison between non septic and septic cases regardingserum calprotectin level. *p*-value=0.000.



Cut off point	AUC	Sensitivity	Specificity	+PV	–PV
≤114.2	1.000	100.00	100.00	100.0	100.0

Fig. (2): Receiver Operating Characteristic Curve (ROC) to assess the predictive accuracy of calprotectin level to detect late-onset neonatal sepsis

Table (6): Relation of calprotectin level with other studied parameters among the studied neonates.

	Calprotectin		Test value	*p*-value
	Median (IQR)	Range		
Mode of delivery:				
CS	23.39 (17.51-102.14)	11.47-507.6	–2.942•	0.003
NVD	14.29 (10.04-17.63)	8.27-23.85		
Mortality:				
Discharged	23.39 (17.63-90.08)	14.62-507.6	–3.864•	0.000
Died	10.92 (9.7-12.8)	8.27-12.98		

CS: Cesarean Section.
NVD: Normal Vaginal Delivery.

Table (7): Correlation between calprotectin level and other studied parameters among the studied neonates.

	Calprotectin	
	r	*p*-value
Gestational age (weeks)	0.836**	0.000
Birth weight (gm)s	0.772	0.000
Age of sampling of calprotectin level (hours)	0.138	0.396
On admission:		
Hb (g/dl)	–0.447**	0.004
HCT (%)	–0.376*	0.017
PLT ($x10^9$/L)	–0.069	0.674
TLC ($x10^9$/L)	0.232	0.150
CRP (mg/L)	–0.238	0.140
After 4 days of admission:		
Hb (g/dl)	–0.144	0.375
HCT (%)	0.001	0.996
PLT ($x10^9$/L)	0.495**	0.001
TLC ($x10^9$/L)	0.365*	0.021
CRP (mg/L)	–0.696**	0.000
After 7 days of admission:		
Hb (g/dl)	0.044	0.793
HCT (%)	0.196	0.238
PLT ($x10^9$/L)	0.775**	0.000
TLC ($x10^9$/L)	0.404*	0.012
CRP (mg/L)	–0.699**	0.000
Duration of hospitalization (Days)	–0.563**	0.000

Hb : Hemoglobin.
HCT: Hematocrit.
PLT : Platelets.
TLC: Total leucocyte count.
CRP: C-reactive protein.

Discussion

Neonatal sepsis occurs within the first month of life and is characterized by a clinical syndrome consisting of bacteremia & systemic signs of infection [9]. Diagnosis of neonatal septicemia still a major problem due to non-specificity of early signs of sepsis and the laboratory data are not fully reliable so that many studies have been ongoing for prediction of neonatal sepsis and identify patients who are at risk of infection [10].

Calprotectin is a heterodimer of a protein that binds calcium & zinc. It is predominantly found in the cytosolic fraction of the neutrophil [11]. Calprotectin exhibits multiple functions, such as inducing apoptosis & regulating phagocyte migration and NADPH oxidase in neutrophils; it also possesses antibacterial, proinflammatory, & oxidant-scavenging properties [12].

Our study aimed to detect the value of serum calprotectin in the first 2 days of life as a predictive marker for late onset sepsis in preterm neonates.

Forty preterm enrolled neonates had no clinical & laboratory evidence of sepsis and then followed-up of these neonates with dividing them later into two groups septic & non-septic ones.

Gestational age & birth weight were significantly reduced in the septic group compared to the control group in our research. Consistent with the research conducted by Terrin et al. [13] which showed that gestational age of the septic group (28.7-29.9 weeks) than non-septic group (29.1-31.1 weeks) with *p*-value <0.001. Also, birth weight of the septic group was significantly lower in the septic group (1029-1135gm) than non-septic group (1080-1275gm) with *p*-value <0.001.

In disagreement with our results Mohamed et al. [14] performed a prospective study on 30 neonates and reported that there wasn't significant variance in age, weight and sex among septic and non-septic groups.

Our results demonstrated that the percentage of neonates on invasive ventilation was significantly greater in septic group (63.6%). Also, the percentage of patients in need for central line insertion was significantly greater in septic group (87.9%).

Near to our results, Terrin et al. [13] showed that ventilatory support was significantly higher in septic group [13].

Our results demonstrated that higher hemoglobin and hematocrit levels on admission in septic group with *p*-values = 0.001 and 0.018 respectively, also significantly higher CRP level in septic group with *p*-value <0.001 after 4 days of admission. Finally, after 7 days of admission there was a statistically significant lower platelets and higher CRP levels in septic neonates with *p*-values = 0.027, <0.001 respectively.

Supporting our results, Attia et al. [15] showed that platelets were significantly lower in septic than non-septic groups, CRP was significantly greater in septic group than non-septic group. But hemoglobin level was insignificantly different between the two groups [15].

Similarly, Abdel-Maaboud et al. [2] demonstrated that there was a significant change among septic & non-septic neonates as regarding mean values of hemoglobin, platelet, TLC and CRP levels.

In the current research, there was a statistically significant lower in calprotectin level in neonates presenting later with late onset sepsis [18.88 (15.49 – 23.85)] ng/ml than non-septic one [327.9 (309.4 – 383.4)] ng/ml with *p*-value <0.001.

Calprotectin is a highly sensitive biomarker in inflammatory processes [16]. However, its efficacy as a marker for sepsis in neonates remains unclear &requires further investigation. Conversely, Calprotectin serves as a critical regulator of neonatal immunity to prevent sepsis. Thus, Heinemann et al. [17] & Ulas et al. [3] reported that following birth, serum concentrations increase physiologically. Thus, the fact that term infants have significantly greater calprotectin levels than preterm infants suggests that low calprotectin levels, particularly in preterm neonates, are correlated with a greater risk of sepsis [18].

The present analysis confirmed that there is a significant negative association between calprotectin levels in the blood stream at birth & the incidence of sepsis, independently of factors such as method of delivery, birth weight or gender. This correlates with the sepsis-protective role that calprotectin serves in neonates [19].

Our results showed that the level of serum calprotectin was significantly lower in neonates with normal vaginal delivery than neonates with cesarean section with *p*-value = 0.003, also the level of serum calprotectin was significantly lower in died cases than discharged cases with *p*-value <0.001.

In our results, the best cutoff value for serum calprotectin level to predict late-onset sepsis was ≤114.2ng/ml with sensitivity and specificity of 100.0% for each & area under curve (AUC) of 1.000.

In their study, Pirr et al. [20] discovered that the OR of LOS was raised 8.3-fold (Ninety-five percent confidence interval 4.15–16.72, *p*-value <0.0001) when the level of serum calprotectin was below a cut-off of 300ng/ml. The positive predictive value was 0.92, the sensitivity was 0.89 and the specificity was 0.51 [20].

Cut-off values may provide neonatologists the ability to identify preterm infants at increased risk of LOS & to prevent the administration of unnecessary empirical antibiotic therapy. Furthermore, the level of serum calprotectin is higher than that of CRP and IL-6, both of which have limited negative predictive possible in neonates due to the delayed peaking of CRP following the onset of sepsis & the variable baseline levels of IL-6 **[21,22].**

Our results demonstrated that there was a statistically significant positive correlation among serum calprotectin level and gestational age (weeks), weight (gm), platelets and TLC levels, negatively correlated with Hb and HCT levels on admission, CRP level after 4 and 7 days of admission and duration of hospitalization.

Contrary to our findings, certain studies have observed significant negative associations among calprotectin levels & gestational ages and weights. These associations may be attributed to the fact that sepsis is more severe in neonates with smaller weights and younger ages, which consequently produce higher levels of these inflammatory markers. **[23-25].**

Furthermore, Mohamed et al. **[14]** demonstrated that there was a significant positive correlation among serum calprotectin level & TLC in septic neonates.

Furthermore, Attia et al. **[15]** showed that serum calprotectin was positively correlated with TLC. However, serum calprotectin was negatively correlated with platelets.

Our study had several limitations. First, the single center study may result in different findings than elsewhere. Second, we didn't follow serum calprotectin levels in septic neonates due to financial problems.

Conclusion:

Serum calportectin level could be used as an early promising biomarkers to predict late onset neonatal sepsis preterms.

In our study, cut off level of serum calprotectin predict neonatal late-onset sepsis was ≤114.2ng/ml with specificity of 100.0%, sensitivity of 100.0%, & area under curve (AUC) of 1.000.

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الكالبروتكتين فى الدم كأول علامة للتنبؤ بتسمم الدم المتأخر فى حديثى الولاده المبتسرين

يعد الإنتان الوليدى سببًا رئيسيًا للوفيات فى جميع أنحاء العالم، وخصوصاً فى الأطفال الخدج، وجود وسيلة للتنبؤ بالإنتان فى الخدج قد تحسن من نتائج الإنتان في هذه الفئة العمرية.

الكالبروتكتين مركب من بروتينين مرتبطين بالكالسيوم ويوجد بكثرة فى الجزء العصاري الخلوي. يفرز الكالبروتكتين بواسطة الخلايا المناعة الفطرية بعد تفاعل كرات الدم البيضاء والمسبب للمرض ويتم إكتشافه فى سوائل الجسم عن طريق الأليزا.

تهدف هذه الدراسة إلى تقييم ما إذا كان من الممكن إستخدام نسبة الكالبروتكتين فى أول يومين من الولادة كعلامة تنبؤية للإنتان المتأخر عند المبتسرين.

في هذه الدراسة، تم تقسيم ٤٠ من الخدج إلى مجموعتين (إنتانية وغير إنتانية) وفقًا لمعايير تولنر ونظام تسجيل أمراض الدم لرودويل ويشترط خدج ذوى عمر رحمى ٣٤ أسبوعًا أو أقل، فى أول يومين من الولادة بدون وجود أى علامات سريرية للإنتان. ويتم إستبعاد الخدج ذوى التشوهات الخلقية ومشاكل خلقية فى الأيض والإختناق الوليدى أو الذين ولدوا لأم مصابة بإلتهاب المشيمة أو تمزق الغشاء المبكر (أكثر من ١٨ ساعة).

تلقى جميع الخدج الرعاية الروتينية لحديثى الولادة، مع أخذ تاريخ مرضي كامل وفحص سريرى مع فحص مختبرى شامل، وتم سحب الكالبروتكتين للخدج الذين ليس لديهم علامات سريرية للإنتان خلال أول يومين من الولادة بواسطة تقنية الأليزا.

أظهرت الدراسة وجود دلالة إحصائية تتمثل في إنخفاض العمر الرحمى والوزن عند الولادة ومعدل الأبجر عند الدقيقة الأولى فى المجموعة المصابة بالإنتان مقارنة بالمجموعة غير المصابة.

كما أظهرت الدراسة أن مدة الإستشفاء والتهوية التداخلية وكذلك وجود وريد مركزى أعلى بكثير فى المجموعة المصابة بالإنتان مقارنة بالمجموعة غير المصابة.

كانت معدلات الهيوجليوبين أعلى في مجموعة الإنتان من المجموعة الأخرى عند دخول الحضانة كما لوحظ إرتفاع نسبة البروتين التفاعلى سى فى المجموعة نفسها بعد ٤ أو ٧ أيام من دخول المحضن.

كان لدى الأطفال المبتسرين فى المجموعة المصابة بالإنتان مستويات أقل بكثير من الكالبروتكتين، فى أول يومين بعد الولادة مقارنة بغيرهم فى المجموعة غير المصابة بالإنتان.