Validation of Peripheral Perfusion Index as a Noninvasive Screening Tool in Predicting Adverse Neonatal Outcome

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Abstract

Introduction: Timely identification of suboptimal organ perfusion is crucial to detect adverse outcomes early and to prevent its long-term motor and cognitive effects. Peripheral perfusion index (PI) is a noninvasive screening tool which can identify babies at risk for hemodynamic compromise. **Aim:** We aimed to study the validity of peripheral PI as an early predictor of adverse neonatal outcome in comparison with other commonly used noninvasive screening modalities such as heart rate (HR), respiratory rate, temperature, capillary refill time (CRT), and blood pressure. **Materials and Methods:** This prospective observational study was carried out between January 2021 and May 2022. All infants born beyond 32 weeks of pregnancy who are admitted to the neonatal intensive care unit and needed hemodynamic were included in the study. Peripheral PI was monitored along with other noninvasive parameters at specific intervals and compared with those parameters for the degree of variation in each at specified time intervals and with the changing hemodynamic status of these babies including adverse outcomes. **Results:** A cohort of 93 neonates was enrolled in the study. Our study found lower PI values among newborns with adverse outcomes. This study also revealed negative correlations between HR and PI, suggesting that low PI could indicate early neonatal compromise and circulatory inadequacy. We also established positive correlations between PI and CRT, systolic blood pressure, mean arterial blood pressure, and pulse pressure. **Conclusion:** PI can serve as a noninvasive screening tool which can identify babies at risk for hemodynamic compromise, especially in resource-poor settings.

Keywords: Neonatal outcome, neonatal shock, neonate, noninvasive hemodynamic monitoring, peripheral perfusion index

Résumé

Introduction: L'identification rapide de la perfusion sous-optimale des organes est cruciale pour détecter les résultats négatifs tôt et pour prévenir ses effets moteurs et cognitifs à long terme. L'indice de perfusion périphérique (PI) est un outil de dépistage non invasif qui peut identifier les bébés à risque de compromis hémodynamique. **Objectif:** Nous avons visé à étudier la validité du PI périphérique en tant que prédicteur précoce du résultat néonatal défavorable par rapport à d'autres modalités de dépistage non invasives couramment utilisées telles que la fréquence cardiaque (HR), la fréquence respiratoire, la température, le temps de recharge capillaire (CRT) et la pression artérielle. **Matériaux et méthodes:** Cette étude d'observation prospective a été réalisée entre janvier 2021 et mai 2022. Tous les nourrissons nés au-delà de 32 semaines de grossesse qui sont admis à l'unité de soins intensifs néonatals et ont besoin d'hémodynamiques ont été inclus dans l'étude. Le PI périphérique a été surveillé avec d'autres paramètres non invasifs à des intervalles spécifiques et comparés à ces paramètres pour le degré de variation dans chacun à des intervalles de temps spécifiés et avec le statut hémodynamique changeant de ces bébés, y compris les résultats défavorables. **Résultats:** Une cohorte de 93 nouveau-nés a été inscrite à l'étude. Notre étude a révélé des valeurs PI plus faibles chez les nouveau-nés avec des résultats défavorables. Cette étude a également révélé des corrélations négatives entre la RH et le PI, ce qui suggère que le faible PI pourrait indiquer un compromis néonatal précoce et une insuffisance circulatoire. Nous avons également établi des corrélations positives entre Pi et CRT, la pression artérielle

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systolique, la pression artérielle moyenne et la pression du pouls. **Conclusion:** PI peut servir d'outil de dépistage non invasif qui peut identifier les bébés à risque de compromis hémodynamique, en particulier dans les contextes de ressources.

Mots-clés: Résultat néonatal, choc néonatal, nouveau-né, surveillance hémodynamique non invasive, indice de perfusion périphérique

INTRODUCTION

Newborns, especially premature infants, in neonatal intensive care units (NICUs) have a higher risk of negative outcomes, and death, particularly during the 1st week of life.[1] Timely identification of suboptimal organ perfusion is crucial to detect such adverse outcomes early and to prevent its long-term motor and cognitive effects in these fragile infants. Prolonged hemodynamic instability can result in acute organ failure due to the immaturity of the cardiovascular and autonomic systems in newborns, especially premature infants. The neonatal circulation is different from that of pediatric and adult populations, reflecting the diverse levels of cardiovascular system maturation in newborns with varying gestational and postnatal ages. A clear understanding of fetal and neonatal cardiovascular pathophysiology is crucial for promptly identifying hemodynamic instability. Adequate circulation is defined as a balanced supply and utilization of oxygen at both the systemic and regional levels. A comprehensive circulatory assessment necessitates monitoring both macrocirculation (systemic blood flow) and microcirculation (blood flow at the capillary level).[2] In clinical settings, the evaluation of tissue perfusion and oxygenation commonly relies on noninvasive methods predominantly centered on systemic circulatory parameters. However, it is known that these approaches inadequately reflect microcirculatory function. Monitoring microcirculation in less essential tissues, particularly in preterm newborns, is crucial during instances of circulatory failure. This allows health-care providers to assess the adequacy of blood flow and oxygen delivery to different areas of the body, even when macrocirculation appears normal. Early detection of tissue hypoperfusion through microcirculation monitoring can prompt timely interventions to prevent organ failure and adverse outcomes. The pulse oximeter has become an indispensable instrument in NICUs for monitoring newborns and measuring oxygen saturation levels in the blood. It also provides the perfusion index (PI), which is a valuable indicator of real-time changes in peripheral blood flow and helps in the identification of inadequate peripheral perfusion in critically ill newborns. PI serves as an easily applicable, noninvasive, and continuous parameter for monitoring newborns. Low PI values have been found to accurately predict high illness severity, reflecting changes in cardiac output and vasomotor tone.[3] This makes PI a valuable indicator in neonatal care. The PI is a numeric value that reflects the ratio between the pulsatile signal (determined by arterial blood flow) and the nonpulsatile signal (determined by skin, subcutaneous tissue, venous blood flow, and other local tissues).

The study by Jiang *et al.* demonstrated that the combined variations in pulse oximetry and PI were statistically significant for congenital heart disease (CHD) screening, suggesting that neonates diagnosed using this combined method are highly likely to have CHD.[4] Mandala *et al.* discovered that PI and pulse variation index effectively demonstrated significant hemodynamic changes, offering a noninvasive means to assess early hemodynamic alterations in neonates unsuitable for invasive procedures.[5] The research conducted by Saikiran *et al.* revealed variations in PI values based on gestational age and the presence of comorbidities, suggesting its potential utility as a valuable instrument for early detection of adverse outcomes in neonates.[6] Ibrahim and Mohamed's study identified that the PI, particularly measured on day 1 and day 3 of NICU admission, serves as a predictive marker for the requirement of inotropic support in neonates, exhibiting strong correlations with comorbidities and neonatal outcomes.[7]

Many of the parameters currently employed in the clinical assessment of newborn perfusion are subjective, leading to either underdiagnosis or overdiagnosis. These parameters are prone to significant inter-observer variability. Consequently, there exists a pressing need for a 34 objective means of identifying and assessing poor perfusion in newborns, aiding in the early identification and management of unwell infants. To address these challenges, we conducted this study to assess the postductal PI values of newborns admitted to the NICU during their 1st week of life, stratified by gestational age, and to investigate its correlation with routine hemodynamic parameters, including heart rate (HR), blood pressure, and capillary refill time (CRT). Furthermore, the research helped to determine the association between PI values and the occurrence of adverse neonatal outcomes, such as asphyxia, shock, respiratory distress syndrome (RDS), anemia, sepsis, pneumonia, and necrotizing enterocolitis, providing valuable insights into the utility of PI as an indicator of neonatal morbidity.

MATERIALS AND METHODS

The research utilized a prospective observational study design and was carried out at a tertiary care center in South India between January 2021 and May 2022. The study subjects are neonates who were admitted to the NICU during that period. All infants born beyond 32 weeks of pregnancy who were admitted to the NICU and needed hemodynamic monitoring for reasons including shock, respiratory distress, perinatal asphyxia, hypoglycemia, convulsions, and sepsis were included in the study. Newborns with significant congenital abnormalities were excluded from the study. Data about general maternal features and demographics were taken from clinical records. Information on newborn sex, gestational age, anthropometric data, and Apgar score were recorded at birth. The newborns included in the study were classified into three groups based on the World Health Organization's gestational age classification as, group 1: moderate preterm (32 - 33 +6 weeks), group 2: late preterm (34-36+6 weeks) and group 3: term (37 - 41+6 weeks).

Tracked clinical markers include HR, pulse volume, CRT, and cold extremities. Blood pressure (systolic, diastolic, and mean pressure) and PI were measured with a pulse oximeter at five different time points: the 1st h of life, 24, 48, 72 h, and day 7. Hypoxic ischemic encephalopathy following birth asphyxia, shock, RDS, anemia, sepsis, pneumonia, necrotizing enterocolitis, patent ductus arteriosus (PDA) with hemodynamic importance, or intraventricular hemorrhage (grade >2) are examples of clinical circumstances that were considered unfavorable and the above mentioned parameters including peripheral perfusion index were carefully monitored in all the babies at the specified time points. Newborns were considered as healthy if they did not exhibit specified conditions, with monitoring techniques such as HR assessment, cold extremity evaluation, pulse volume measurement, CRT determination, blood pressure measurement, and PI recording, while clinical criteria for poor perfusion encompassed a weak and fast pulse, CRT exceeding 3 s, cold extremities, and additional signs such as lethargy, unresponsiveness to stimulation, and a very pale complexion. The sample size was calculated based on the prevalence of bad outcomes of 53.3% ($n = 84$).[1] Nonetheless, the consecutive sampling approach was used to collect a sample of 93 newborns in all. Data analysis was performed using SPSS 23 is a statistical software developed by IBM for data management and advanced analytics software. The data were presented as mean ± standard deviation (SD) for continuous measurements and as percentages for categorical measurements. Significance was evaluated at the 5% level. Chi-square and logistic regression analyses were used to examine the relationship between the variables. Pearson's correlation coefficient was used to determine the correlation coefficient between the PI and other hemodynamic variables, such as HR, CRT, and blood pressure. In addition, a receiver operating characteristic (ROC) curve was constructed to predict clinical shock and hypotension from the PI.

Results

A cohort of 93 neonates was enrolled in the study. Among these neonates, 59.1% were male, whereas 40.9% were female. The median gestational age stood at 35.4 weeks, with a range spanning from 33.1 to 37.7 weeks. In this cohort, 31 neonates were categorized as moderate preterm (33.3%), 30 as late preterm (32.3%), and 32 as term (34.4%). The mean gestational age observed in the study was 35 weeks and 4 days, with an SD of 2 weeks and 3 days. The gestational age ranged from a minimum of 32 weeks and 0 days to a maximum of 41 weeks and 1 day.

The mean maternal age recorded was 26.8 years, with an SD of 4.30 years and a range spanning from 19 to 41 years. Furthermore, the mean maternal birth weight was 2.292 kg, with an SD of 0.72 kg and a range of 0.84–3.9 kg. The average length of the newborns was 45.5 cm, with an SD of 3.22 cm and a range from 39 to 52 cm. The mean head circumference measured was 32.9 cm, with an SD of 1.90 cm and a range between 27.5 and 36.0 cm. In addition, the average Apgar score at 1 min postbirth was 7.91, with an SD of 0.73 and a range of 6–9. At 5 min postbirth, the average Apgar score was 8.77, with an SD of 0.42, where the majority of scores were high (H = 8) and few were low (L = 9). Demographic factors and distribution in terms of gestational age are presented in Table 1.

In this study, we found that there was no significant differences in temperature among different gestational groups or between different adverse outcome groups. However, there was a notable difference in HR among gestational groups at 24 h postbirth,

Table 1: Demographic factors and distribution in terms of gestational age

	Frequency			
	Moderate preterm	Late preterm	Term	Total
Gestational age	31	30	32	93
Sex				
Male	16	19	20	55
Female	15	11	12	38
Maternal age				
≤25	12	15	14	41
26–30	9	12	16	37
>30	10	3	2	15
Birth weight				
Normal	0	12	30	42
Extremely low	3	0	0	3
Very low	9	1	0	10
Low	19	17	2	38
Length				
≤45	1	12	23	36
46–50	1	12	23	36
>50	0	0	6	6
Head circumference				
≤30	9	0	0	9
30.1–33	22	14	1	37
>33	0	16	31	47

Table 2: Difference in oxygen saturation between different gestational groups

Oxygen saturation	Moderate preterm (n=31)	Late preterm (n=30)	Term (n=32)	*P*
1 h	93.8±1.80	95.9±1.53	98.0±0.47	0.000 (S)
24 h	94.8±1.31	98.0±0.26	98.0±0.00	0.000 (S)
48 h	95.4±0.99	99.0±0.00	98.8±0.80	0.000 (S)
72 h	97.8±1.28	98.8±0.46	99.0±0.00	0.000 (S)
7 days	98.2±0.96	98.7±0.69	99.0±0.00	0.000 (S)

Results expressed as mean±SD. ANOVA test was performed. S=Difference is significant at 0.05 level. SD=Standard deviation. ANOVA=Analysis of variance but not at 1 h, 48 h, 72 h, or 7 days. A significant change was observed in HR between different adverse outcomes at 1 h, but not at 24 h, 48 h, 72 h, and 7 days.

Oxygen saturation showed significant differences among gestational groups at various time points: 1 h, 24 h, 48 h, 72 h, and 7 days [Table 2]. Yet, no significant differences were observed in oxygen saturation between different adverse outcome groups at these same time points. Regarding CRT, no significant differences were found between different gestational groups at 24 h, 48 h, 72 h, or 7 days. However, there was a significance found at 1 h on CRT between different adverse outcomes.

Significant disparities were noted in systolic blood pressure across varying gestational groups as well as among different adverse outcome categories [Table 3] at multiple time intervals: 1, 24, 48, 72 h, and 7 days postbirth. In addition, significant distinctions were observed in diastolic blood pressure among distinct gestational groups as well as between different adverse outcomes. A significant difference was noted in pulse pressure among various gestational groups, as well as in mean arterial pressure across these groups (data not shown).

Furthermore, significant distinctions were observed in mean arterial pressure between different adverse outcomes at 1 and 48 h postbirth, while no statistical significance was found at 24, 72 h, and 7 days. In addition, there was a significant variance in the PI among different gestational groups, as well as between different adverse outcomes [Table 4].

Finally, we examined the relationship between diastolic blood pressure, pulse pressure, mean arterial pressure, and PI. Significant correlations were found between diastolic blood pressure and PI, pulse pressure and PI, as well as mean arterial pressure and PI, with P values below the significance level of 0.05. These correlations indicated that as diastolic blood pressure, pulse pressure, and mean arterial pressure increase, the PI also increases, while decreases in these blood pressure parameters correspond to decreases in the PI [Table 5].

Table 3: Difference in systolic blood pressure between different gestational groups

Systolic blood pressure	Moderate preterm (n=31)	Late preterm (n=30)	Term (n=32)	P
1 h	62.6±6.07	69.5±5.59	71.2±5.58	0.000 (S)
24 h	60.2±6.23	69.3±5.41	70.7±5.10	0.000 (S)
48 h	63.7±6.63	69.8±4.59	69.9±5.72	0.000 (S)
72 h	66.5±3.84	70.0±3.97	71.9±4.56	0.000 (S)
7 days	70.2±3.95	71.7±3.34	72.8±3.64	0.000 (S)

ANOVA test was performed. S=Difference is significant at 0.05 level, ANOVA=Analysis of variance

Table 4: Difference in perfusion index between different adverse outcomes

PI	1 h	24 h	48 h	72 h	7 days
Asphyxia (n=1)	1.42	2.20	2.32	3.10	2.60
Shock (n=8)	0.53±0.18	0.51±0.16	1.07±0.23	1.31±0.36	1.52±0.52
RDS (n=9)	0.80±0.25	0.91±0.29	1.38±0.31	1.71±0.68	1.92±0.62
Anemia (n=2)	0.76±0.18	0.85±0.16	1.25±0.07	1.75±0.49	1.88±0.60
Sepsis (n=5)	0.47±0.28	0.81±0.26	0.93±0.33	1.29±0.59	1.81±1.04
Pneumonia (n=3)	1.25±0.47	0.91±0.03	1.21±0.36	1.64±0.40	1.81±0.51
NEC (n=1)	0.81	1.32	1.28	1.62	1.96
PDA (n=5)	1.41±0.25	1.40±0.41	1.42±0.37	1.84±0.39	2.86±0.63
IVH >2 (n=3)	0.95±0.24	0.98±0.28	1.27±0.98	1.73±1.19	2.00±1.22
No adverse (n=56)	1.81±0.66	2.01±0.75	2.07±0.64	2.40±0.80	2.76±0.77
P	0.000 (S)	0.000 (S)	0.000 (S)	0.001 (S)	0.000 (S)

Kruskal–Wallis test was performed. S=Difference is significant at 0.05 level, RDS=Respiratory distress syndrome, PI=Perfusion index, PDA=Patent ductus arteriosus, IVH=Intraventricular hemorrhage, NEC=Necrotizing enterocolitis

Table 5: Relationship between different variables and perfusion index

Variables	Value	PI	R	P
Diastolic blood pressure	42.08±6.3		0.28	0.006
Pulse pressure	25.7±3.5	1.42±0.74	0.44	0.000
Mean arterial pressure	50.52±6.32		0.36	0.000

Results expressed as mean±SD. Pearson correlation analysis was performed. SD=Standard deviation, PI=Perfusion index

Receiver operating characteristic curve analysis

The cutoff value for PI to predict adverse outcome is 0.95. The area under the curve (AUC) is 0.895 (0.863–0.927). Using the above cutoff, the sensitivity of peripheral PI as a screening tool is 70.3%, specificity is 92.9%, positive predictive value is 86.7%, negative predictive value is 82.5%, and overall accuracy is 83.9% [Figure 1a]. The cutoff value for PI to predict hypotension is 0.95. AUC is 0.594 (0.528–0.660). Using the above cutoff, sensitivity is 45.5%, specificity is 71.8%, positive predictive value is 33.3%, negative predictive value is 81.0%, and overall accuracy is 65.6% [Figure 1b].

Discussion

Peripheral PI reflects the real-time changes in peripheral blood flow and would be expected to be affected by changes in the arterial circulation. PI provides an unambiguous value and can provide easy, noninvasive, and unattended monitoring of illness severity in neonates.[8] In this study, a cohort of 93 newborns was analyzed, comprising 33.3% of moderate preterm, 32.3% of late preterm, and 34.4% of term neonates. The median gestational age was determined to be 35 weeks and 4 days. Analysis of sex distribution revealed a predominance of males (59%) over females (41%). The average maternal age was 26.8 years with a standard deviation of 4.30, ranging from 19 to 41 years. Notably, anthropometric measurements including birth weight, length, and head circumference were significantly higher in preterm infants with advanced gestational age.

We observed distinct postductal PI values during the 1st week of life corresponding to gestational age. Moderate preterm newborns exhibited lower PI values compared to late preterm and term infants. In addition, there was a notable positive

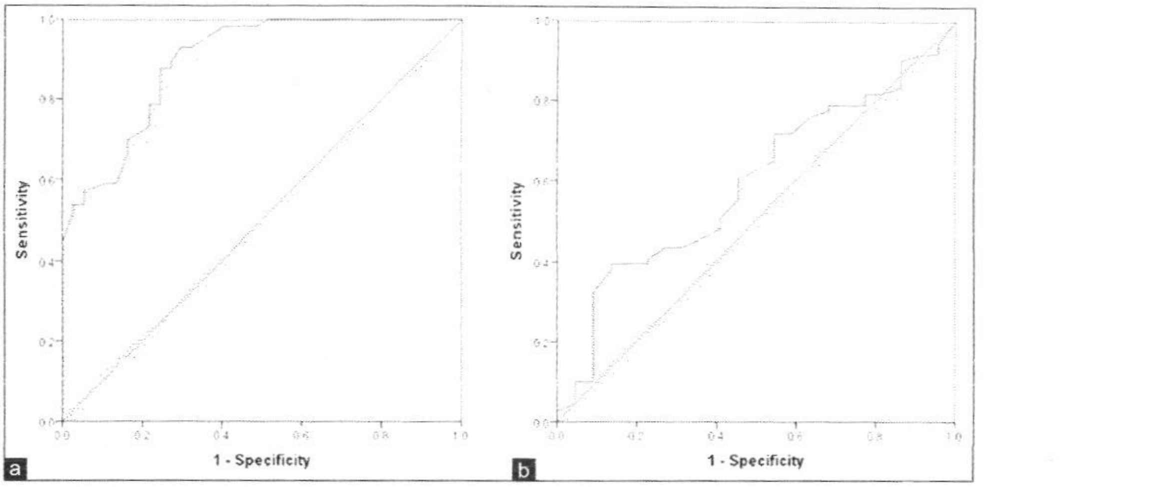

Figure 1: Receiver operating characteristic (ROC) curve of perfusion index for the prediction of hypotension and adverse outcome. (a) ROC curve of adverse outcome, (b) ROC curve of hypotension

linear trend in PI values with increasing gestational age, with statistically significant differences observed across various time points (P: 1st h $P = 0.001$, 24 h $P = 0.000$, 48 h, $P = 0.000$, 72 h $P = 0.000$, 168 h $P = 0.000$).

Furthermore, the present study showed that age-dependent variations in peripheral PI recordings were evident, showing a significant rise in median PI values from the first to the 3rd day of life. These findings underscore the importance of considering both gestational age and postnatal age when interpreting PI values in neonatal assessments. Our investigation revealed notable fluctuations in PI values alongside other hemodynamic parameters such as HR, temperature, CRT, and blood pressures during the initial hours of life, followed by a tendency toward stabilization around the 72-h mark. This observed trend in PI underscores the physiological variability of peripheral microvascular blood flow immediately postbirth, likely linked to intrinsic hemodynamic adaptation occurring in the early neonatal period.

Studies by Cresi *et al.* demonstrated significant increases in PI values from the first to the third day of life, with values further escalating by the 7th day.[9] Conversely, findings by another study showed a nonsignificant decline in PI during the initial 48 h, followed by stability thereafter.[1] De Felice *et al.* highlighted a perfusion cycle in preterm newborns, characterized by low blood flow and high vascular resistance in the initial 24 h, succeeded by normal high flow and low resistance, presumably due to vasodilatation.[10]

Hakan *et al.* reported that PI values reached a steady state by the 5th day of life[3] with similar observations made by Hawkes *et al.*, who described high variability in PI values during the transitional period.[11] Both studies noted the initial high variability in PI, consistent with our findings. In addition, an inverse relationship between PI values and gestational age was noted, with lower median PI values observed in newborns with adverse outcomes, particularly in those with pathological conditions.

Our study found significantly lower median PI values in newborns experiencing adverse outcomes across various time points. Furthermore, the moderate preterm group exhibited a higher incidence of adverse outcomes compared to late preterm and term groups, with RDS, shock, sepsis, and PDA being the most prevalent adverse events. The median PI value in our study population was 1.42, with an interquartile range of 0.83–2.75. Comparable findings were reported by other authors, including Monteiro *et al.*, Hakan *et al.*, Cresi *et al.*, Vidal *et al.* and Kinoshita *et al.*, and Lima and Bakker observed a skewed distribution of PI in adults, with a median value of 1.4, highlighting potential variations based on the inclusion of newborns with different gestational ages and clinical conditions.[1,3,9,12-14] Granelli and Ostman-Smith established reference values for peripheral PI in healthy newborns, suggesting values lower than 0.70 could indicate illness.[15]

These collective findings contributed to a comprehensive understanding of PI dynamics in neonatal populations, aiding in the early identification of clinical conditions and guiding appropriate interventions. Our study observed median PI values in different gestational age groups, indicating lower PI values in preterm infants compared to term newborns, suggesting a need for reevaluation of PI cutoffs for indicating morbidity in preterm neonates. We also noted that pulse oximeter reliability and accuracy can be challenging under various conditions, such as ambient light exposure, skin pigmentation, and motion artifact, potentially affecting PI measurements.

Furthermore, pathological conditions such as neonatal sepsis, hypovolemia, and CHDs can alter microvascular blood flow and cardiovascular adaptation in early neonatal life, particularly in preterm neonates during the transitional period. Our study found lower PI values among newborns with adverse outcomes, with moderate preterm infants showing a higher incidence of adverse outcomes compared to late preterm and term infants. Previous research corroborated our findings, showing significant associations between lower PI values and higher severity of illness. In addition, our study revealed negative correlations between HR and PI, suggesting that low PI could indicate hypotension and circulatory inadequacy.

We also established positive correlations between PI and CRT, systolic blood pressure, mean arterial blood pressure, and pulse pressure. These findings indicated that PI can serve as a potential indicator of poor perfusion and hypotension in newborns.

Using ROC curves, we determined cutoff values for PI to predict shock and hypotension in at-risk neonates. While PI showed promise as a predictor of morbidity and mortality risk in newborns, its reliability in predicting hypotension was limited due to higher false positivity rates. Overall, our study underscores the potential of PI as a parameter for monitoring microcirculation and assessing morbidity risk in newborns, with implications for early detection and intervention to prevent acute organ dysfunction and failure.

Limitations of the study

The necessity for detailed subgroup analysis based on gestational age might restrict the ability to detect significant differences due to smaller subgroup sizes.

Conclusion

Our study highlights the significance of PI as a valuable parameter for assessing microcirculation and predicting morbidity risk in neonates. We observed distinct variations in PI values across different gestational age groups, with lower PI values associated with adverse outcomes, particularly in moderate preterm infants. The correlations between PI and various hemodynamic parameters further underscore its potential as an early indicator of poor perfusion and hypotension. While PI shows promise in neonatal monitoring, further research is warranted to validate its utility across diverse clinical settings and populations, with implications for enhancing neonatal care and outcomes.

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Conflicts of interest

There are no conflicts of interest.

References

1. Costa Monteiro S, Correia-Costa L, Proença E. Perfusion index in preterm newborns during the first week of life and association with neonatal morbimortality: a prospective observational study. J Pediatr Neonat Individual Med 2017;6:e060212. doi: 10.7363/060212.
2. Vrancken SL, van Heijst AF, de Boode WP. Neonatal hemodynamics: From developmental physiology to comprehensive monitoring. Front Pediatr 2018;6:87.
3. Hakan N, Dilli D, Zenciroglu A, Aydin M, Okumus N. Reference values of perfusion indices in hemodynamically stable newborns during the early neonatal period. Eur J Pediatr 2014;173:597-602.
4. Jiang SL, Zhan YJ, Yan P, Yue Y, Tang J. Pulse oximetry and perfusion index screening for congenital heart defects: A systematic review and meta-analysis. Am J Perinatol 2023;40:1611-7.
5. Mandala VK, Mendu SB, Bollaboina SK, Kotha R Sr. Role of perfusion index and pulse variability index in the assessment of neonatal hemodynamics: A systematic review. Cureus 2023;15:e48058.
6. Saikiran M, Manoj GS, Shanthi AS, Saikiran M. A study of perfusion index in preterm and term babies. Int J Adv Res 2022;9:428-31.
7. Ibrahim M, Mohamed M. Validity of perfusion index in prediction of circulatory compromise and mortality in neonates. Ain Shams Med J 2023;74:1:57-64.
8. Aoyagi T, Miyasaka K. Pulse oximetry: Its invention, contribution to medicine, and future tasks. Anesth Analg 2002;94:S1-3.
9. Cresi F, Pelle E, Calabrese R, Costa L, Farinasso D, Silvestro L. Perfusion index variations in clinically and hemodynamically stable preterm newborns in the first week of life. Ital J Pediatr 2010;36:6.
10. De Felice C, Latini G, Vacca P, Kopotic RJ. The pulse oximeter perfusion index as a predictor for high illness severity in neonates. Eur J Pediatr 2002;161:561-2.
11. Hawkes GA, O'Toole JM, Kenosi M, Ryan CA, Dempsey EM. Perfusion index in the preterm infant immediately after birth. Early Hum Dev 2015;91:463-5.
12. Vidal M, Ferragu F, Durand S, Baleine J, Batista-Novais AR, Cambonie G. Perfusion index and its dynamic changes in preterm neonates with patent ductus arteriosus. Acta Paediatr 2013;102:373-8.
13. Kinoshita M, Hawkes CP, Ryan CA, Dempsey EM. Perfusion index in the very preterm infant. Acta Paediatr 2013;102:e398-401.
14. Lima A, Bakker J. Clinical monitoring of peripheral perfusion: There is more to learn. Crit Care 2014;18:113.
15. Granelli AD, Ostman-Smith I. Noninvasive peripheral perfusion index as a possible tool for screening for critical left heart obstruction. Acta Paediatr 2007;96:1455-9.