To Study the Comparison of Invasive and Non-Invasive Blood Pressure Values in Neonates with Predisposing Factors for Shock

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ABSTRACT

INTRODUCTION
Immune in shock measurement of blood pressure of neonates is very important to decide the treatment. Non-Invasive Blood Pressure (NIBP) measurement is commonly used when direct measurement is impractical. Invasively measured arterial Blood Pressure (IBP) measurement is done in critically ill patients. The present study aimed to find out the difference between IBP and NIBP values in neonates with predisposing factors for shock.

MATERIAL AND METHODS
This was a hospital based prospective cross-sectional study conducted in year of 2022 in the department of pediatrics at Pt JNMCH, Raipur. The sample size calculated for the study was 120 thus 240 observations. Simultaneously 8-10 reading of IBP and NIBP were taken in all neonates with predisposing factors for shock such as birth asphyxia, prematurity. Blood investigations of neonates were done and written informed consent was taken from their parents.

RESULTS
In present study the major risk factor for shock in neonates was prematurity (60.8%), birth asphyxia (26.7%) and sepsis (11.7%). The systolic and diastolic BP measurement value in IBP technique was 22.708 mmHg and 19.758 less than NIBP technique ($p<0.01$). In both techniques neonates with normal CRT values have higher BP values than those with prolonged CRT value. Sepsis was found in 5.83% neonates and 15% were died.

CONCLUSION
NIBP technique shows higher BP reading than actual BP therefore NIBP is better tool for screening. IBP technique shows actual BP, so IBP technique is more accurate for BP monitoring in intensive care unit, and it is safe and easily doable.

KEYWORDS
Blood pressure, Shock, NIBP, IBP, Neonates

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INTRODUCTION

In neonates hemodynamic monitoring is important as it encompasses the observation and measurement of hemodynamic parameters over time. Shock is a complex clinical syndrome caused by an acute failure of circulatory function and is characterized by an imbalance between tissue demand and the supply of substrates.[1] Therefore measurement of blood pressure of neonates is very important to decide the treatment. Measurement of the arterial Blood Pressure (BP) in neonates was introduced more than 60 years ago. In subsequent decades, various techniques for arterial BP measurement were developed and numerous tables of observed BP values for neonates across a broad range of Gestational Ages at birth (GA) and postnatal ages.[2]

Although blood pressure is most accurately measured directly (intra arterially) though non-invasive blood pressure measurement is commonly used when direct measurement is either unavailable or impractical. Invasively measured arterial Blood Pressure (IBP) measurement is an integral part of the management of critically ill patients and is considered to be the gold standard for Blood Pressure (BP) measurement. However, it places them at risk of bleeding, infection and requires more clinical expertise than noninvasive monitoring.[3] Automated Non-Invasive Blood Pressure (NIBP) systems using oscillometric techniques and proven beneficial over the invasive arterial lines to avoid these risks. NIBP may not be sufficiently accurate in critically ill patients, leading to erroneous interpretations of BP and possible errors in clinical decisions. There is a need for validation studies comparing the accuracy and precision of monitoring of BP using noninvasive and invasive methods is commonly used when direct measurement is either unavailable or impractical.[4] Invasively measured arterial Blood Pressure (IBP) measurement is an integral part of the management of critically ill patients and is considered to be the gold standard for Blood Pressure (BP) measurement. However, it places them at risk of bleeding, infection and requires more clinical expertise than noninvasive monitoring. Automated Noninvasive Blood Pressure (NIBP) systems using oscillometric techniques and proven beneficial over the invasive arterial lines to avoid these risks. NIBP may not be sufficiently accurate in critically ill patients, leading to erroneous interpretations of BP and possible errors in clinical decisions. There is a need for validation studies comparing the accuracy and precision of monitoring of BP using noninvasive and invasive methods.[5]

AIM AND OBJECTIVE

Aim: To compare and find out the difference between invasive BP and non-invasive BP values in neonates with predisposing factors for shock.

Objective:

1. Simultaneously measure the BP by both invasive and non-invasive methods in neonates with predisposing factors for shock.
2. To compare the finding of IBP & NIBP values in neonates with shock.

MATERIALS AND METHODS

This was a hospital based prospective cross-sectional analytical study conducted from January 2022 to December 2022.[6] The study was conducted in the department of pediatrics at Pt JNMCH and Dr. BRAM hospital, Raipur, Chhattisgarh. All admitted newborn in NICU of DR. BRAM hospital Raipur with the predisposing factors for shock were taken as study population. This calculator uses the following formula for the sample size $n=(Z\alpha/2+Z\beta)2^*2^*\sigma^2/d^2$, Sample size was calculated for comparing two sample means by using formula $n=(Z\alpha/2+Z\beta)2\ *2*\sigma^2/d^2$, and taking confidence interval at 95%, power 80%, at hypothesized difference of 12.[7] The sample size for was 110 and with 10% non-response rate we included 120 samples and thus 240 observations. Study was conducted to find out the difference between IBP and NIBP values in neonates and role of IBP in management of shock. Simultaneously 8-10 observations were taken to measure IBP and NIBP in all neonates with predisposing factors for shock such as birth asphyxia, prematurity. Data of all neonates included in the study was collected on following schedule: Detailed history including demographic details, Detailed Examination, BP measurement values by IBP and NIBP technique. Investigation done in the study subjects were: Complete haemogram, Blood glucose, Serial and quantitative CRP, CRT value and blood culture. The outcome of the patient was recorded at the time of discharge. Data was entered in Microsoft excel using specified format and analysis was done using SPSS-20 version.[8] Frequency and percentages were calculated whenever required. Data was presented in mean and standard deviations. For statistical analysis paired sample t test was used to measure the mean difference in NIBP and IBP BP measurement values and Independent sample t test was used to study the association b/w decreased urine output and NIBP and IBP values. Statistical significance was taken P value <0.05. Written informed consent was taken from the parents were explained about the study.[9]

RESULTS

In present study 120 neonates with shock included in the study.[10] The major risk factor for shock in neonates was the RDS (prematurity) (60.8%), birth asphyxia (26.7%), sepsis (11.7%) and one case was having prenatal asphyxia with HIE. Table 1 shows the difference in mean NIBP and IBP measurement values in neonates. It shows that systolic BP measurement value in IBP technique was 22.708 mmHg less than NIBP technique. Similarly diastolic BP measurement value in IBP technique was 19.758 mmHg less than NIBP technique. The mean difference in systolic and diastolic BP values in NIBP and IBP technique was statistically significant ($p<0.01$).[11]

Methods BP measurement	No of cases	Mean BP value	Std. deviation	Mean difference	t	P value
NIBP Systolic	120	74.76	12.437	22.708	28.18	p<0.01
IBP Systolic	120	52.05	10.533			
NIBP Diastolic	120	53.75	10.72	19.758	22.241	p<0.01
IBP Diastolic	120	33.99	8.953			

Table 1. Mean Difference in NIBP and IBP Measurement Values in Neonates.

Table 2 shows the association b/w NIBP and IBP values with CRT level in neonates. It shows that in NIBP technique those with normal CRT values have 25.64 mmHg more systolic BP values than those with prolonged CRT value and the association was statistically significant ($p<0.01$).[12] Similarly those have normal CRT values have 20.78 mmHg more diastolic BP values than those with prolonged CRT values and

this was statistically significant (p<0.01). Table 2 also shows that in IBP technique those have normal CRT values have 17.2 mmHg more systolic BP values than those with prolonged CRT and this was statistically significant (p<0.01). Similarly those have normal CRT values have 10 mmHg more diastolic BP values than those with prolonged CRT and this was statistically significant (p<0.01).[13]

BP methods	CRT	No of cases	Mean BP value	Std. Deviation	Mean difference in BP value	95% Confidence Interval of the Difference		P value
						Lower	Upper	
NIBP Systolic	<3 sec	98	79.46	5.19	25.64	22.14	29.13	p<0.01
	>3 sec	22	53.82	13.77				
NIBP Diastolic	<3 sec	98	57.56	6.76	20.78	17.48	24.09	p<0.01
	>3 sec	22	36.77	8.36				
IBP Systolic	<3 sec	98	55.2	7.94	17.2	13.38	21.02	p<0.01
	>3 sec	22	38	9.17				
IBP Diastolic	<3 sec	98	35.83	8.66	10	6.22	13.79	p<0.01
	>3 sec	22	25.82	4.65				

Table 2. Association b/w NIBP and IBP Values with CRT Level in Neonates.

Table 3 shows that in IBP technique those with decreased urine output have 20.24 mmHg less systolic BP values and 14.29 less diastolic BP values than those with normal urine output and this was statistically significant (p<0.01). In NIBP technique those have decreased urine output have 17.61 less systolic BP values and 14.72 less diastolic BP than those with normal urine output and this was statistically significant (p<0.01).[14]

BP methods	Decreased Urine output	No of cases	Mean BP value	Std. deviation	Mean difference in BP value	95% Confidence interval of the difference		P value
						Lower	Upper	
NIBP Systolic	Yes	17	59.65	16.96	-17.61	-23.23	-11.98	p<0.01
	No	103	77.25	9.54				
NIBP Diastolic	Yes	17	41.12	12.31	-14.72	-19.61	-9.82	p<0.01
	No	103	55.83	8.91				
IBP Systolic	Yes	17	38.71	10.63	-15.55	-20.24	-10.85	p<0.01
	No	103	54.25	8.78				
IBP Diastolic	Yes	17	25.41	3.22	-10	-14.29	-5.71	p<0.01
	No	103	35.41	8.81				

Table 3. Association b/w NIBP and IBP Values and Decreased Urine Output in Neonates in 1st 24 hrs.

Table 4 shows that in NIBP technique those with tachycardia have 13.014 mmHg more systolic and 12.387 more diastolic BP values than those with no tachycardia and this was statistically significant (p<0.01).[15] In IBP technique those with tachycardia have 7.802 mmHg more systolic and 7.803 mmHg more diastolic BP values than those with no tachycardia and this was statistically significant (p<0.01).

BP methods	Tachycardia	No of cases	Mean BP value	Std. deviation	Mean difference	95% confidence interval of the difference		P value
						Lower	Upper	
NIBP Systolic	No	103	76.6	11.01	13.01	6.98	19.03	p<0.01
	Yes	17	63.59	14.93				
NIBP Diastolic	No	103	55.5	9.54	12.38	7.28	17.49	p<0.01
	Yes	17	43.12	11.58				
IBP Systolic	No	103	53.16	9.94	7.8	2.5	13.09	0.004
	Yes	17	45.35	11.77				
IBP Diastolic	No	103	35.1	8.96	7.8	3.36	12.24	0.001
	Yes	17	27.29	5.3				

Table 4. Association b/w NIBP and IBP Values with Tachycardia Status in Neonates.

Table 5 shows that among study subjects sepsis was found in 7 (5.83%) cases and improved in 15 (12.5%) cases and in 98 (81.67%) cases no onset of sepsis was reported.

Sepsis status	Freq.	Percent
Yes	7	5.83
Improved	15	12.5
No	98	81.67
Total	120	100

Table 5. Sepsis Status in Study Subjects.

Outcome	Freq.	Percent
Death	18	15
Improved and discharged	112	85
Total	120	100

Table 6. Treatment Outcome in Shock Patients.

Table 6 shows that treatment outcome in shock patients, 85% improved after treatment and discharged and 15% died. Out of 18 death cases 12 (66.66%) were of RDS (Prematurity) cases, 5 (22.22%) cases were of birth asphyxia.[16]

DISCUSSION

The present study conducted with the purpose to compare and find out the difference between invasive BP and non-invasive BP values in neonates with predisposing factors for shock. The major risk factor for shock in neonates was the RDS (prematurity) (60.8%), birth asphyxia (26.7%) and sepsis (11.7%).[17] Leal YA, et al. reported that prematurity (65.7%), perinatal asphyxia (24.9%), low Apgar score at birth (19.4%) emerged as independent factors for shock. Murthy S, et al. reported that delivery <37 weeks of gestation (70%), birth asphyxia (22.9%) and sepsis (7.1%) were significant risk factor for shock. In present study the NIBP technique of BP measurement has systolic BP value more than 22.708 mmHg than IBP technique. Similarly, NIBP technique of BP measurement has diastolic BP value more than 19.758 mmHg than IBP technique (p<0.01).[18] Takci S, et al. and did a similar study and reported that in presence of hypotension non-invasive measurements were found significantly higher compared with invasive measurement

($p<0.05$). Dasnadi S, et al. studied the factors influencing the accuracy of NIBP measurements in neonates at NICU. They reported the poor agreement between IBP and NIBP measurements, the mean blood pressure percent difference was 28.3 mmHg. In present study the correlation b/w NIBP and IBP systolic and diastolic value shows a positive and statistically significant correlation (Spearman Rho 0.716, $p<0.001$), (Spearman Rho 0.875, $p<0.001$).[19] Umapathi KK, et al. and Kumar A, et al. in a similar study a positive significant correlation between IBP and NIBP of 0.887 Spearman Rhop <0.001). Findings of the present study shows that in both NIBP and IBP technique patient with normal CRT values have higher systolic and diastolic BP values than those with prolonged CRT value and the association was statistically significant ($p<0.01$). Similar findings were reported by Umapathi KK, et al. and Werther T, et al. that in both NIBP and IBP technique those with normal CRT values have significantly more systolic BP values. Findings of the present study shows that in both IBP and NIBP technique those with decreased urine output have less systolic and diastolic BP values than those with normal urine output. Dasnadi S, et al. reported that in both NIBP and IBP technique those have decreased urine output have less systolic and diastolic BP values than those with normal urine output. Zhou J, et al. also reported from a similar study that in both NIBP and IBP technique those have decreased urine output have less systolic and diastolic BP values than those with normal urine output. Findings of the present study shows that cases with tachycardia have higher systolic and diastolic BP values in both NIBP and IBP technique those with no tachycardia and this was statistically significant ($p<0.01$). Jagadeesh AM, et al. reported the statistically significant association b/w tachycardia with NIBP and IBP values ($p<0.01$) [28]. Takci, S et al. did the comparison between oscillometric and invasive blood pressure measurements in critically ill premature infants. They reported that in both NIBP and IBP technique those with tachycardia have more systolic and diastolic BP values. In present study among study subjects' sepsis was found in 7 (5.83%) cases, Cather was removed, and catheter tip was sent for culture but no organism has been grown in rest of the culture tests and 15% were died. Takci S, et al. did a similar study and reported that during the procedure sepsis was found in 10.23% neonates and 12% were died. Dasnadi S, et al. reported that during the study period sepsis was found in 8.62% neonates and 9.38% were died.[20]

CONCLUSION

NIBP technique shows higher BP reading than actual BP therefore NIBP is better tool for screening. IBP technique shows actual BP, so IBP technique is more accurate for BP monitoring in intensive care unit, and it is safe and easily doable. Other marker of shock which was commonly used is urine output, tachycardia and CRT values. Urine output is poor marker of early-stage shock and tachycardia is nonspecific marker of shock, though CRT is a good marker of shock. Though sepsis is an inevitable side effect of IBP but it can be minimized by taking proper care of aseptic measures.
Limitation of this study is not using markers of tissue perfusion for monitoring of shock but can be used in further studies.

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