(International Print/Online Journal)

SJIF IMPACT FACTOR: 5.565
PUBMED-National Library of Medicine ID-101739732

ISSN (Print): 2209-2870
ISSN (Online): 2209-2862

International Journal of Medical Science and Current Research (IJMSCR)
Available online at: www.ijmscr.com
Volume 5, Issue 2, Page No: 726-735
March-April 2022

IJMSCR

Mean Arterial Pressure And Capillary Refill Time In Sick Newborns

[1]Dr.Neha, [2]Dr Manpreet Sodhi*, [2]Dr.Jaswir Singh, [3]Dr.Ashwani Kumar
[1,2*,3]M.D, [2]M.D.,FIMSA,
[1]Mata Kaushalya Hospital,Patiala
[2]Department of Pediatrics and [3]Department of Physiology,
Government Medical College, Patiala, India

***Corresponding Author:**
Dr. Manpreet Sodhi
M.D, Department of Pediatrics, Government Medical College, Patiala, India

Type of Publication: Original Research Paper
Conflicts of Interest: Nil

Abstract

Objective: To study various factors influencing mean arterial pressure(MAP) and capillary refill time(CRT) in sick newborns and to find the correlation between two parameters.

Methods:It was prospective observational study done on 150 newborns admitted to tertiary care hospital over a period of one year.Out of 150 newborns , 100 were sick and 50 healthy, served as control. MAP was recorded in a calm baby by Flush method on right upper extremity in radiant warmer in supine position. CRT was assessed with index finger on mid sternum in well lighted room. SPSS software was used for data entry and analysis.

Results: The difference in MAP of newborns with CRT<3S and CRT>3S was statistically insignificant in preterm (p=0.423)and term(p=0.088) babies.The difference in MAP of newborns with CRT<3S and CRT>3S was statistically significant in newborns only with birth weight 1000-1499g and 2000-2499g respectively (p<0.05).The difference in MAP of newborns with CRT<3S and CRT>3S was statistically insignificant in all morbidity groups.MAP of cases with CRT<3S was 45.49±6.134 mm of Hg and with CRT >3S was 43.33±7.563mm of Hg(p=0.047). There was significant correlation between CRT and MAP in sick newborns(r value=-0.199).

Conclusion: The significant determinants of MAP in sick newborn are gestational age and birth weight .It was independent of day of life and morbidities as septicemia,meningitis and hyperbilirubinemia.CRT is independent of gestational age, birth weight and day of life as well.But it varied significantly in all morbidities.MAP is correlated inversely with CRT in sick newborns.

Keywords: Capillary refill time,Mean arterial pressure, Sick newborn

Introduction

Shock is a common clinical situation confronted in newborn. It is a complex clinical syndrome caused by an acute failure of the circulatory function characterized by inadequate tissue and organ perfusion. A shock is compensated initially, when the perfusion to the vital organs like brain, heart, and adrenals is preserved by sympathetic reflexes. It is clinically characterized by tachycardia, cool peripheral skin, and prolonged capillary refill time.If left untreated, compensated shock may lead to uncompensated shock. Clinically, it presents as falling blood pressure, very prolonged capillary refill time, tachycardia, cold skin, rapid breathing and reduced or absent urine output.[1] Usually, mean arterial blood pressure(MAP), rather than systolic blood pressure, is used in the assessment of hemodynamic status of a patient. Mean Arterial Blood Pressure is thought to be free from the artifact caused by resonance, thrombi, and air bubbles, but this may not always be true.

Blood Pressure can be monitored by various invasive and noninvasive methods. An indwelling arterial line is the most accurate method to measure blood pressure. But being invasive, it is not a practical method in most of the clinical situations. The various non invasive methods to measure blood pressure include Oscillometric method, Doppler method, Flush method.[2]Oscillometric and Doppler method measuring instruments are not widely available in most neonatal centres in India. Flush Method,introduced by Gaertner in 1899 and widely used by Cappe and Pallin, this method is based on the visualization and correlation with cuff pressure of flushing due to re-entry of blood after the hand or foot is rendered bloodless. Flush Method to measure newborn blood pressure is advantageous in certain aspects as there is no requirement of any expensive equipment. It can be carried out in noisy surroundings also. It is adequate for most clinical situations. Peripheral vascular stasis of the newborn and visible cyanosis due to congenital heart disease have no effect on the end point.It is an indicator of mean arterial pressure. There are various determinants of blood pressure in a neonate; gestational age, postnatal age, birth weight, maternal age, weight for gestational age, mode of delivery, perinatal asphyxia and various systemic disorders like RDS(Respiratory Distress Syndrome), septicemia, NNH(Neonatal hyperbilirubinemia) and DIC(Disseminated Intravascular Coagulation).

Capillary refill is the rate at which blood refills empty capillaries. Capillary Refill Time (CRT) is defined as the time required for the normal skin color to reappear after a blanching pressure is applied. It is considered to be helpful in the assessment of circulatory status.[6] The common observation that CRT is prolonged in shock makes it a sensitive test for peripheral circulatory failure. CRT is a quickly performed bedside test to assess the inadequacy of circulation in an individual with poor cardiac output. Normal capillary refill takes around 2 seconds. A delay in the capillary filling time is one of the best ways to diagnose shock. Significant differences occurred between the mean CRT recorded by the two observers in forehead, palm and heel. Only CRT in chest produced no significant differences in the means statistically and was clinically fair.[3]

Therefore, the site which was found to be free from most of the confounding factors is chest (midpoint of sternum). We, in this project have chosen the chest as the site to perform CRT.

In this study, we attempt to study the various factors influencing mean arterial pressure in our study population and to relate the same with capillary refill time.

Subjects And Methods

The study was prospective observational descriptive hospital based study on 150 newborns admitted to Neonatology section of tertiary care hospital in North India,Punjab over a period of one year. Out of the 150 newborns, 100 comprised the study group and 50 were in the control group.The study was approved by institutional ethical committee. Informed consent was taken from the parents of babies before the enrollment in the study.

Study group included sick newborns suffering from:-

1. Septicemia
2. Meningitis
3. DIC, bleeding & coagulation disorders
4. Shock
5. Respiratory Distress Syndrome(RDS) included HMD(Hyaline Membrane Disease) Pneumonia, MAS(Meconium Aspiration Syndrome), TTN(Transient Tachypnea Of Newborn)) or Respiratory Distress due to any other problem like Diaphragmatic hernia, TOF(Tracheo-oesophageal Fistula) etc.
6. Jaundiced baby (NNH) undergoing Phototherapy

These babies were either Term, Preterm or Postterm. Term were the babies born between 37 to 41 completed weeks of gestation.Preterm were the babies born before 37 completed weeks of gestation.Post-term were the babies born with 42 weeks of gestation or more.[4]

Control Group included healthy newborns who were either Term, Preterm or Postterm. Healthy Newborn was a newborn who did not suffer from the aforementioned ailments.

Method

MAP measurement was done by FLUSH method[2],Introduced by Gaertner in 1899 and later used by Cappe and Pallin and Goldring and Wohltman for determination of blood pressure in hands and feet of infants. This method is based on visualization and correlation with cuff pressure of

Volume 5, Issue 2; March-April 2022; Page No 726-735

flushing due to reentry of blood after the hand or foot is rendered bloodless.

The cuff was applied to the wrist for an upper extremity reading. The hand was then compressed by firmly wrapping it with an elastic bandage beginning at the digits and wrapping proximally to the lower edge of the cuff to facilitate the drainage. The extremity was maintained at a level well above the heart. The cuff was inflated to 200 mmHg, the elastic bandage removed and extremity was returned to the heart level. The pressure within the cuff was gradually reduced until the flushing of the blanched distal portion was observed. This was the predecided end point, which if the rate of deflation did not exceed 5 mm Hg, reflected Mean Arterial Pressure.

The procedure was carried out in a well lit room. Infants were in supine position and were as quiet and inactive as possible. If the baby cried during the procedure, it was repeated.The length of the cuff used in the procedure was such that it completely encircled the wrist of the baby, so that flushing was uniform. The width of the cuff used was 5cm.[5]

Capillary Refill Time (CRT) Assessment[6]

CRT was measured by applying enough pressure to blanch the area for 5 seconds and then,removing the finger.The time was counted in seconds with a digital watch till the blanched skin regained its color. The site chosen in this project to assess the CRT was the midpoint of the sternum.The patients were assessed lying supine in radiant warmer, or crib. Each newborn was assessed once only. If for any reason, the measurement had to be repeated, a period of 30 seconds was allowed before the next attempt. The assessment was made in a well lit room.The readings of mean arterial pressure obtained by the Flush method were compared with the values from control group. Then an attempt was made to relate the mean arterial pressure and capillary refill time in sick newborns.

The data so obtained was analyzed statistically by t test and pearson chi square test.Chi squaretest was used for comparison of various parameters. Multivariate regression analysis was done for determining the association between various factors and $p<0.05$ was considered statistically significant.SPSS software was used for data entry and analysis.

Results:

The baseline characteristics of cases and control groups were comparable except for day of life(Table 1).In the study, morbidity from which maximum newborns were suffering was Respiratory Distress Syndrome(RDS). MAP of the cases group was 45.36±6.69 mmHg. MAP of the control group was 47.52±7.04 mmHg($P=0.069$). A trend of increasing MAP with increasing gestational age in both cases and control groups was observed(Table2).The difference of MAP in cases and control newborns in various gestational age groups was not significant($P>0.05$). However, the correlation of MAP with gestational age was found to be significant in both cases ($r=0.556, p<0.001$) and control ($r=0.573, p<0.001$) groups individually i.e. MAP increases with increasing gestational age. Amongst cases, the number of newborns with CRT < 3 sec was more than the newborns with CRT > 3 sec in each of the gestational age group(Table3).100% of the control newborns had CRT < 3 sec. The number of newborns with CRT > 3 sec was significantly more among sick newborns than their healthy counterparts in both term ($p=0.001$) and preterm ($p=0.004$) groups (Table 3). The difference in the MAP of newborns with CRT < 3 sec and CRT > 3 sec was statistically insignificant in each of the gestational age groups ($p=0.423$ for preterm and $p=0.088$ for term) (Figure 1). Statistical analysis showed that within cases, the CRT did not vary with gestational age($r= -0.005, p=0.609$). There was significant difference in CRT of the cases and control newborns in both preterm and term groups(Table 3). MAP was observed to increase with increasing birth weight in cases. The same relation was observed in control newborns also except in those with birth weight of 1500-1999g(Table2).

Correlation of MAP with birth weight was significant in both cases($r=0.797$) and control($r=0.821$) groups, except in birth weight 1500-1999gms in controls. The statistical analysis revealed that within cases the CRT did not vary with birth weight ($r= -0.003$). There was a significant difference in the CRT of cases and control in all birth weight categories except 1000-1499g(Table3).The difference in the MAP of the newborns with CRT < 3 sec and CRT > 3 sec was statistically significant in newborns with birth weight 1000-1499g and 2000-2499g group($P<0.05$).This difference was statistically insignificant in newborns

Volume 5, Issue 2; March-April 2022; Page No 726-735

with birth weight 1500-1999g and ≥ 2500g group(p>0.05). All morbidities studied in the study group tend to produce lower MAP than healthy control group. Statistical evaluation revealed that there was no significant difference in the MAP of cases with septicemia, meningitis and NNH undergoing phototherapy and control newborns(p>0.05). However, there was significant difference in the MAP of cases with DIC, coagulation and bleeding disorders, shock and RDS and control newborns(p<0.001),it was lower (Table2). It was observed that the difference in the CRT of newborns of the control group and each of the morbidity group was statistically significant(Table3). MAP of the newborns with CRT > 3 sec was observed to be lower than those with CRT <3 sec in septicemia, meningitis, RDS, NNH undergoing phototherapy while it was observed to be higher in newborns with DIC, coagulation and bleeding disorders with CRT> 3 sec than those with CRT <3 sec(figure2). The difference in the MAP of newborns with CRT<3sec and CRT>3 sec was statistically insignificant in all the morbidity groups (p=0.804 for septicemia, p=0.178 for meningitis, p=0.667 for DIC, coagulation and bleeding disorders, p=0.089 for R.D. and p=0.173 for NNH undergoing phototherapy).

The present study revealed that within the control group, there was a significant correlation between MAP with DOL (r= 0.717, p<0.001) i.e. MAP increased with increasing DOL. There was no such correlation between MAP and DOL in cases (r= -0.057, p=0.069). MAP of sick newborns was significantly lower than healthy newborns in all DOL categories except on DOL 1 (Table 2). CRT was found to be independent of postnatal age of the sick newborns (r= - 0.025, p=0.757). The number of newborns with CRT > 3 sec, among sick newborns, was significantly more than their healthy counterparts only till DOL 4 (Table 3). MAP of newborns with CRT > 3 sec was lower than those with CRT < 3 sec in each of the DOL category. Statistical evaluation revealed that the difference in the MAP of newborns with CRT < 3 sec and CRT > 3 sec was not significant in any of the DOL categories(P>0.05).

MAP of cases with CRT<3sec was 45.49 ± 6.134 mm of Hg and with CRT>3 sec was 43.33 ± 7.563 mm of Hg. MAP of newborns with CRT > 3 sec was observed to be lower than the newborns with CRT < 3 sec(p=0.047) Statistical analysis revealed that there was a significant inverse correlation between CRT and MAP in sick newborns i.e. MAP declined in sick newborns with CRT > 3 sec(r=-0.199) as shown in Table 4.

Discussion

MAP, in the present study, of cases group was 45.36 ± 6.69 mm Hg while that of control group was 47.52 ± 7.04 mm Hg (p=0.069),statistically non significant.

Cordero et al[7] evaluated MAP during the first 24 hours of life either by oscillometry or direct transducer readings through an umbilical line, in 101 ELBW(extremely low birth weight) infants (36 stable and 65 unstable) and found that MAP of the stable infants was higher than the unstable infants throughout the 24 hours, in contrast to the present study. The dissimilarity in the results could be explained by the fact that in the study conducted by Cordero et al, only ELBW infants were examined and that too only during the first 24 hours, unlike the present study.

The present study revealed that MAP increased with increasing gestational age of the newborn in both cases and control groups . There was no significant difference in MAP of sick and healthy newborns in any of the gestational age groups. The number of newborns with CRT > 3 sec was significantly more among sick newborns than their healthy counterparts in both term and preterm groups . The difference in the MAP of newborns with CRT < 3 sec and CRT > 3 sec was statistically insignificant in each of the gestational age groups.

The results of the present study were consistent with the following studies, though Blood Pressure was measured in these studies by methods other than Flush Method.Zubrow et al[8] recorded BP in 608 newborns admitted to NICU by oscillometry and found that it correlated significantly with gestational age and birth weight(p<0.01) on day one of life.Also Lee etal[9] recorded invasive BP in VLBW found it to be related with gestation (r=0.44 to 0.74) and birth weight(r=0.49).Pejovic et al[10] recorded mean BP by non invasive method in stable newborns and found that it increases with gestational age and birth weight.

Where as in studies done by Cordero et al[7] in ELBW concluded that MAP was more in infants with >27 wks gestation than26 wks gestation ,similarly

Volume 5, Issue 2; March-April 2022; Page No 726-735

Emery et al[11] studied BP in VLBW in first 2 days both by invasive and non invasive methods and found that it correlated significantly with gestational age($p<0.01$).

As far as birth weight is concerned , similarly Gillman et al[12] found that Systolic BP increases with 2.9 mm for every Kg increase in birth weight and Salihoglu et al[13] had significant correlation between birth weight and MBP($r=0.20, p<0.001$).

Some studies have found contrary results to present study that BP does not have correlation with birth weight[7,14].Though authors had babies from 500 to 2000 g and took maximum and minimum limits of SBP and DBP instead of MBP.In present study ELBW comprised of only 3.3% of total population.

In present study CRT was found to be independent of gestation and birth weight.Same were observations by Srozik et al[15] for gestation and byRaichur et al[16] and Woodey et al[17] for birth weight.

MAP of cases in present study was significantly lower in cases with DIC, Coagulation and bleeding disorders ,shock and RDS than control group.The difference in CRT of newborns of control and each of morbidity group was statistically significant.The difference in MAP of newborns with CRT<3sec and CRT>3sec was statistically insignificant in all morbidity groups.Same were observations in severe RDS, birth asphyxia and septic shock by authors[18-21] who found that mean BP was decreased.The present study is also consistent with that of Strozik et al[16] who found significant difference in CRT of receivers and non receivers of phototherapy.

MAP of sick newborns was significantly lower than healthy newborns in all DOL categories except DOL ≤ 1 (Table 2). CRT was found to be independent of postnatal age of the sick newborns ($r= - 0.025$, $p=0.757$). The number of newborns with CRT > 3 sec, among sick newborns, was significantly more than their healthy counterparts only till DOL 4. The present study is in contrast to that done by Zubrow et al [8],who recorded BP in 608 newborns admitted to NICU indirectly by oscillometry and found that during first 5 days, there was progressive rise in BP regardless of gestational age or weight at birth($r=0.655, p<0.0001$). He had babies with varied morbidity in contrast to that in present study.Studies comparing MAP and CRT in sick newborns as per gestation, birth weight , morbidity profile and DOL were not available in the literature.

There was a significant inverse correlation between CRT and MAP in sick newborns i.e. MAP declined in sick newborns with CRT > 3 sec ($r= - 0.199$, $p= 0.047$).

The present study results were inconsistent with those of LeFlore et al[22] who assessed CRT on 3 sites including lower sternum and mean BP by oscillometry on 42 newborns within first 4 hours of life and found a moderate direct correlation between MBP and CRT ($r=0.43$, $p=0.005$) i.e. prolongation of CRT occurred with elevated blood pressure. The authors have commented, in their study, as this finding to be unanticipated and have attributed the cause of the same to increased circulating vasoactive substances in the newborn period which were also not measured in their study.

It can be concluded from present study that significant determinants of MAP in sick newborn are gestational age ,birth weight and morbidities as DIC,coagulation and bleeding disorders , shock and respiratory distress syndrome.It was independent of day of life and other morbidities as septicemia,meningitis and neonatal hyperbilirubinemia.CRT is independent of gestational age, birth weight and day of life as well.But it varied significantly in all morbidities.MAP is correlated inversely with CRT in sick newborns.

Contributors

Dr Neha conceptualised and designed the study.Dr. Manpreet Sodhi did the data analysis and drafted the manuscript. . Dr.Jaswir Singh helped in execution of study and collected the data Dr. Ashwani Kumar supervised the execution of study. All the authors have read and approved the final version of manuscript.

"Table1: Baseline characteristics of cases and control newborns"

CHARACTERISTIC	CASES(N=100)	CONTROLS (N=50)	P VALUE

Volume 5, Issue 2; March-April 2022; Page No 726-735

GESTATION	NO(% of Cases)	NO(% of cases)	
Preterm	53(53)	20(40)	
Term	45(45)	29(58)	0.317
Post term	2(2)	1(2)	
BIRTH WEIGHT(g)			
<1000	4(4)	1(2)	
1000-1499	15(15)	2(4)	
1500-1999	20(20)	11(22)	0.315
2000-2499	29(29)	16(32)	
≥2500	32(32)	20(40)	
MORBIDITY			
Septicemia	32(32)		
Meningitis	7(7)		
DIC,Coagulation/Bleeding Disorders	3(3)		
Shock	9(9)		
Respiratory Distress Syndrome(RDS)	85(85)		
Neonatal Hyperbilirubinemia(NNH)undergoing Phototherapy	34(34)		
DAY OF LIFE(DOL)			
≤1	27(27)	28(28)	
2-4	41(41)	17(17)	
5-7	22(22)	3(3)	
>7	10(10)	2(2)	
MEAN ARTERIAL PRESSURE(mm of Hg)	45.36±6.69	47.52±7.04	0.069

"Table2: Mean arterial pressure(MAP) in relation to gestation, birth weight,morbidity and day of life"

GESTATION	CASES	CONTROLS	P VALUE
Preterm	42.19±4.79	43.00±4.61	0.517
Term	48.40±6.39	50.14±6.57	0.262
Post Term	61.00±1.49	62.00±0.0	0.667
BIRTH WEIGHT(g)			
<1000	36.5±1.00	38.00±0	0.272

Volume 5, Issue 2; March-April 2022; Page No 726-735

1000-1499	38.93±3.92	42.00±5.66	0.331
1500-1999	40.20±3.43	41.45±3.7	0.351
2000-2499	45.45 ±2.38	45.38±4.18	0.940
≥2500	52.63±4.67	53.60±5.75	0.506
MORBIDITY			
Septicemia	45.75±5.787	47.52±7.04	0.238
Meningitis	46.00±4.761	47.52±7.04	0.583
DIC,Coagulation/Bleeding Disorders	39.33±1.55	47.52±7.04	<0.001
Shock	36.22±5.333	47.52±7.04	<0.001
Respiratory Distress Syndrome(RDS)	44.71±6.523	47.52±7.04	0.020
Neonatal Hyperbilirubinemia(NNH)undergoing Photoherapy	46.94±6.592	47.52±7.04	0.705
DAY OF LIFE(DOL)			
≤1	43.63±6.588	43.43±3.563	0.888
2-4	47.02±7.445	51.65±7.115	0.304
5-7	45.91±5.255	53.33±5.033	0.031
>7	42.00±4.619	61.00±1.414	<0.001

"Table3: Capillary refill time(CRT) in relation to gestation, birth weight,morbidity and day of life"

	CASES		CONTROLS		
GESTATION	CRT<3 SEC	CRT>3SEC	CRT<3SEC	CRT>3SEC	PVALUE
Preterm	36	17	20	0	
Term	32	13	29		0.004
Post term	2	0	0		0.001
BIRTH WEIGHT(g)					
<1000	4	0	1		
1000-1499	9	6	2		0.515
1500-1999	13	7	11		0.033
2000-2499	22	7	16		0.04
≥2500	22	10	20		0.008
MORBIDITY					

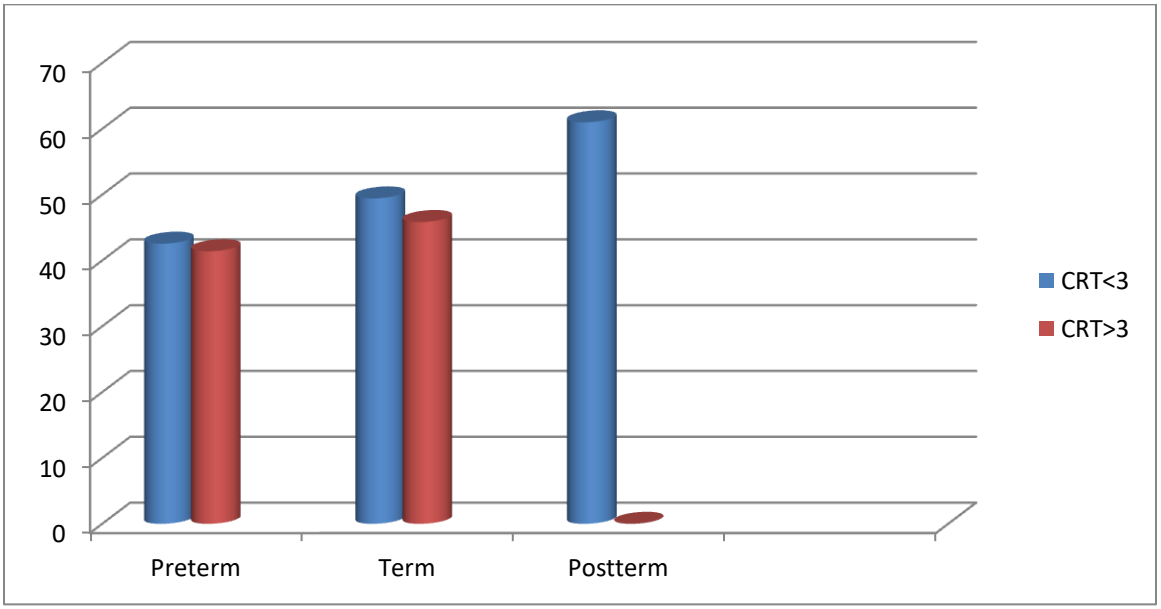
Volume 5, Issue 2; March-April 2022; Page No 726-735

Septicemia	23	9			
Meningitis	5	2			
DIC, Coagulation/Bleeding Disorder	2	1			
Shock	0	9			
Respiratory Distress Syndrome(RDS)	56	29			
Neonatal Hyperbilirubinemia(NNH) undergoing phototherapy	29	5			
DAY OF LIFE(DOL)					
≤1	18	9	28		0.001
2-4	29	12	17		0.012
5-7	17	5	3		1.000
>7	6	4	2		0.515

"Table4: Correlation of mean arterial pressure and capillary refill time in sick newborns"

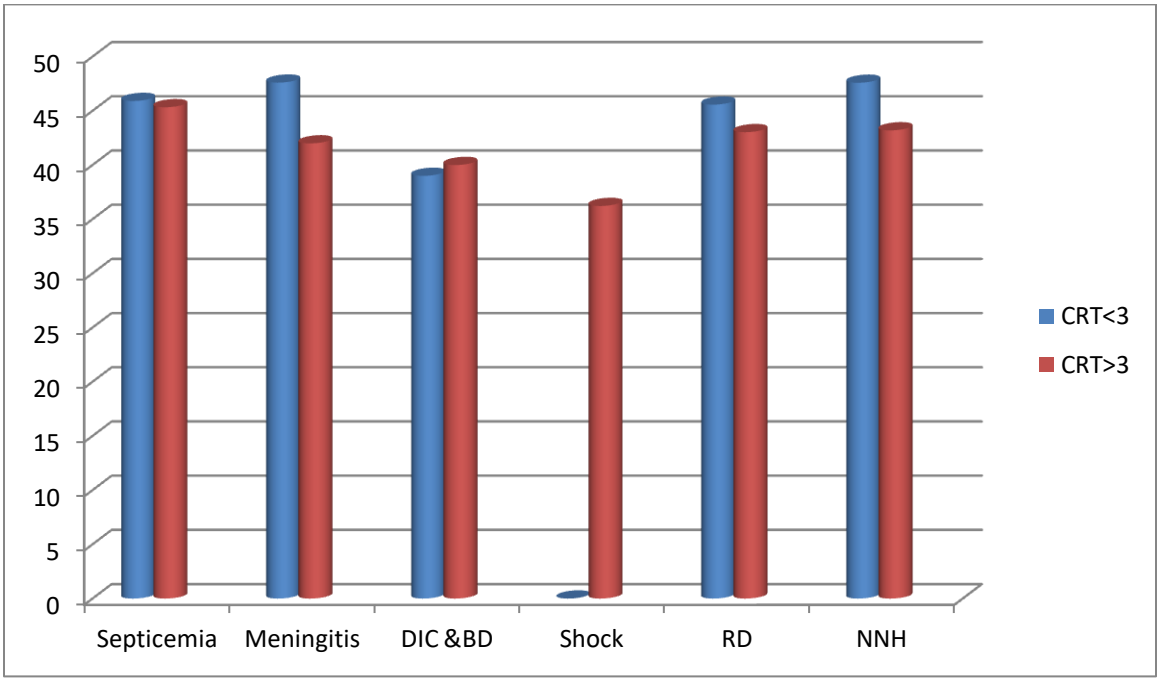
	CRT<3 SEC(N=70)	CRT>3SEC(N=30)	P VALUE	CORRELATION COFFICIENT (r value)
Mean Arterial Presurre(MAP)	45.49±6.134	43.33±7.563	0.047	-0.199

Figure1: Comparison of Mean Arterial Pressure and Capillary Refill Time in sick newborns as per gestational age



Volume 5, Issue 2; March-April 2022; Page No 726-735

Figure2: Comparison of Mean Arterial Pressure and Capillary Refill Time in sick newborns as per morbidity profile(DIC-Disseminated Intravascular Coagulation,BD-Bleeding Disorder,RD-Respiratory Distress, NNH-Neonatal Hyperbilirubinemia)



REFERENCES

1. Gupta S, Sinha SK, Donn SM. Shock and Hypotension in the newborn. Available from: http://www.medscape.emedicine.com/ article/979128
2. Moss AJ. Blood Pressure in infants, children and adolescents. West J Med. 1981Apr;134:296-314.
3. Raichur DV, Aralihond AP, Kasturi AV, Patil DH. Capillary Refill Time in Term neonates: Bedside Assessment. Indian Journal of Pediatrics 2001;68(7):613-15
4. Ghosh S and Bhargava SK. Nomenclature for the newborn. Indian Pediatrics 1974;11(6):443-47.
5. O`Brien ET and O`Malley K. ABC of Blood Pressure Measurement. British Medical Journal 1979;27:1049.
6. Strozik K, Pieper C, Roller J. Capillary refilling time in newborn babies: normal values. Arch Dis Child Fetal Neonatal Ed. 1997 May; 76(3): F193–F196.
7. Cordero L, Timan CJ, Waters HH, Sachs LA. Mean arterial pressures during the first 24 hours of life in < or = 600-gram birth weight infants. J Perinatol. 2002 Jul-Aug;22(5):348-53**.**
8. Zubrow AB, Hulman S, Kushner H, Falkner B. Determinants of blood pressure in infants admitted to neonatal intensive care units: a prospective multicenter study. J Perinatol. 1995 Nov-Dec;15(6):470-9.
9. Lee J, Rajadurai VS, Tan KW. Blood pressure standards for very low birthweight infants during the first day of life. Arch Dis Child Fetal Neonatal Ed. 1999;81:F168–F170.
10. Pejovic B, Peco-Antic A, Marinkovic-Eric J. Blood pressure in non-critically ill preterm and full-term neonates. Pediatr Nephrol. 2007 Feb;22(2):249-57.
11. Emery EF, Greenough A, Yuksel B. Effect of gender on blood pressure levels of very low birthweight infants in the first 48 hours of life. Early Hum Dev. 1993 Jan;31(3):209-16.
12. Gillman MW, Rich-Edwards JW, Rifas-Shiman SL, Lieberman ES, Kleinman KP, Lipshultz SE. Maternal age and other predictors of newborn blood pressure. J Pediatr. 2004 Feb;144(2):240-5.

Volume 5, Issue 2; March-April 2022; Page No 726-735

13. Salihoğlu O, Can E, Beşkardeş A, Koç BŞ, Tan I, Can G et al. Delivery room blood pressure percentiles of healthy, singleton, liveborn neonates. Pediatr Int. 2012 Apr;54(2):182-9.

14. Hegyi T, Carbone MT, Anwar M, Ostfeld B, Hiatt M, Koons A et al. Blood pressure ranges in premature infants. I. The first hours of life. The Journal of Pediatrics. 1994 Apr;124(4):627-33.

15. Strozik K, Pieper C, Roller J. Capillary refilling time in newborn babies: normal values. Arch Dis Child Fetal Neonatal Ed. 1997 May; 76(3): F193–F196.

16. Raichur DV, Aralihond AP, Kasturi AV, Patil DH. Capillary Refill Time in Term neonates: Bedside Assessment. Indian Journal of Pediatrics 2001;68(7):613-15.

17. Wodey E, Pladys P, Bétrémieux P, Kerebel C, Ecoffey C. Capillary refilling time and hemodynamics in neonates: a Doppler echocardiographic evaluation. Crit Care Med. 1998 Aug;26(8):1437-40.

18. Korvenranta H, Kero P, Valimaki I. Cardiovasular monitoring in infants with respiratory distress syndrome. Biol Neonate. 1983;44(3):138-45.

19. Hegyi T, Carbone MT, Anwar M, Ostfeld B, Hiatt M, Koons A et al. Blood pressure ranges in premature infants: II. The first week of life. Pediatrics. 1996 Mar;97(3):336-42.

20. van Bel F, Latour V, Vreman HJ, Wong RJ, Stevenson DK, Steendijk P et al. Is carbon monoxide-mediated cyclic guanosine monophosphate production responsible for low blood pressure in neonatal respiratory distress syndrome? J Appl Physiol. 2005 Mar;98(3):1044-9.

21. Kermorvant-Duchemin E, Laborie S, Rabilloud M, Lapillonne A, Claris O. Outcome and prognostic factors in neonates with septic shock. Pediatr Crit Care Med. 2008 Mar;9(2):186-91.

22. LeFlore JL and Engle WD. Capillary refill time is an unreliable indicator of cardiovascular status in term neonates. Adv Neonatal Care. 2005 Jun;5(3):147-54.

Volume 5, Issue 2; March-April 2022; Page No 726-735