

# Determinants of Capillary Refill Time in Healthy Neonates

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## ABSTRACT

**Objectives:** Traditionally Capillary refilling time (CRT) has been used as a widely accepted method to assess cardiac output and peripheral circulation in neonates. There are only few studies describing normal values and the correct method of recording CRT. The value of CRT is affected by various factors like ambient or skin temperature, age, site of measurement, duration as well as amount of pressure and inter observer variation. However, none of these have been standardized. Hence, we conducted this study to establish the normal value and factors affecting Capillary Refilling Time (CRT) in healthy neonates in Varanasi.

**Design:** Prospective observational study done over a period of 2 years.

**Setting:** Maternity wards and Neonatal intensive care unit of Sir Sunderlal Hospital, Institute of Medical Sciences, Banaras Hindu University, Varanasi, India.

**Participants:** Healthy neonates between 35-42 weeks of gestation staying with their mothers and admitted in neonatal intensive care unit.

**Materials and Methods:** CRT was measured by standard technique four times during first week of life on day 1, 3, 5 and 7.

**Statistics Analysis:** Student t-test was used for analysis. A p-value less than 0.05 was taken as statistically significant.

**Results:** The mean capillary refilling time (CRT) was  $2.23 \pm 0.37$  seconds in healthy neonates during first week of life. We studied each neonate four times in first week of life. Significantly lower values of CRT were noted in low birth weight babies throughout first week in healthy neonates. Babies under phototherapy and radiant warmer had also shorter CRT values. Values were not affected by age, sex and gestation.

**Conclusion:** The normal value of capillary refilling time (CRT) in healthy neonate is less than three seconds. The major determinants of CRT in healthy neonate are birth weight, radiant warmer and phototherapy. CRT alone in neonatal age is less informative haemodynamic parameter; it should be evaluated along with either blood pressure or oxygen saturation with pulse oxymeter. Further studies are needed to assess the reliability and validity of CRT as a clinical tool to measure perfusion in neonates.

**Keywords:** Cardiac output, Factors affecting, Normal neonates, Peripheral circulation

## INTRODUCTION

Capillary refilling time (CRT) has been used as a widely accepted method to assess cardiac output and peripheral circulation especially in neonates. Measurement of blood pressure is difficult in newborns due to lack of easy availability of adequate sized cuff & electronic multichannel monitor. Invasive blood pressure monitoring again, is cumbersome in neonates. Under such circumstances, capillary refilling time (CRT) has been broadly used as an accepted method to assess cardiac output and peripheral circulation. There is paucity of literature describing normal values, range and the correct method of recording CRT. The value of CRT is affected by age, ambient or skin temperature and site of measurement [1], duration as well as amount of blanching pressure and inter observer variation [2]. CRT is also being affected by nursery equipments like warmer and phototherapy [3].

Earliest description of CRT in literature was by Buerger [4] and later on, Beecher proposed this measure as a means of grading shock [5]. CRT is defined as the time required for return of normal colour after application of blanching pressure to a distal capillary bed [2]. Upper limit of CRT has been reported to be 2 seconds [3,6,7]. We planned this prospective study to establish the normal values of CRT in healthy neonates and to see the effects of different factors viz birth weight, gestational age, body temperature, warmer and phototherapy on CRT in healthy neonates.

## MATERIALS AND METHODS

This prospective descriptive study was conducted from 1st August 2006 to July 31<sup>st</sup>, 2007 in Maternity wards and Neonatal intensive care unit of Sir Sunderlal Hospital, Institute of Medical Sciences, Banaras Hindu University, Varanasi. The study was approved by

Institutional Ethical Committee. Consent was taken from parents. Inclusion criteria were: (i) normal healthy neonates between 35-42 weeks of gestational age within 12-24 hours of life.

Exclusion criteria were: (i) Sick newborn with any illness; (ii) major congenital anomaly; (iii) neonates with shock; (iv) parental consent was refused.

The study population comprised 627 healthy neonates between 35-42 weeks of gestational age and between 12 hours to 7 days of life. Capillary refilling time was measured on 4 occasions at 12-24 hours, on day 3, day 5 and day 7 of life. CRT was measured by pressing index finger over mid sternum of baby with 5 seconds with simultaneous activation of stopwatch by other observer. Complete return of skin colour after removal of finger was taken as capillary refill time. Each participant's CRT was recorded thrice one minute apart & the average of three values was taken as true value. The newborns were assessed in supine position either in mother's lap, crib or under radiant warmer and phototherapy unit. Birth weight was recorded on electronic weighing machine. Gestational age was calculated from first day of mother's last menstrual period and confirmed in case of disparity by New Ballard Score. Baby temperature was recorded from axilla with digital thermometer for 2 minutes while ambient temperature from room thermometer. These newborn were longitudinally studied from day 1; however, some of these neonates were discharged from hospital before the completion of study. The number of neonates available for study on subsequent time periods after day1 of life was less. Data were filled into performa, evaluated at the end of the study for normal values including upper & lower values; assessed for influencing factors age (in days), gender, birth weight, gestational age, temperature,

Parameters		CRT day1 ± S.D.	CRT day3 ±S.D.	CRT day5 ± S.D.	CRT day7 ± S.D.
Birth weight	< 2500	2.13 ± 0.41	2.15 ± 0.37	2.16 ± 0.37	2.13 ± 0.33
(grams)	n	221	168	113	100
	≥2500	2.28 ± 0.35	2.27 ± 0.35	2.28 ± 0.36	2.27 ± 0.32
	n	406	215	168	148
	p-value	0.001	0.002	0.005	0.001
	36-36.5°C	2.17 ± 0.33	2.30 ± 0.26	2.34 ± 0.29	2.36 ± 0.27
Temperature	n	78	23	25	17
(Axilla)	36.6-37.5 °C	2.23 ± 0.39	2.21 ± 0.37	2.32 ± 0.37	2.20 ± 0.33
	n	548	348	253	230
	p-value	0.14	0.01	0.066	0.112
Warmer	Yes	66	43	28	16
	No	2.18 ± 0.40	2.21 ± 0.36	2.25 ± 0.36	2.23 ± 0.33
	n	561	328	250	232
	P-value	0.247	0.243	0.006	0.004
Phototherapy	Yes	2.35 ± 0.50	2.25 ± 0.36	2.03 ± 0.35	1.91 ± 0.34
	n	20	10	17	9
	No	2.22 ± 0.38	2.22 ± 0.36	2.24 ± 0.36	2.23 ± 0.33
	n	6250	371	265	239
	p-value	0.608	0.810	0.015	0.004

**[Table/Fig-1]:** Factors affecting capillary refill time (in seconds) in healthy neonates (Mean ± Standard Deviation S.D)

neonatal hyperbilirubinaemia, mode of delivery, use of warmer and phototherapy units.

## STATISTICS ANALYSIS

Statistical analysis was done using paired t-test.

## RESULTS

A total of 627 healthy neonates (368 males) were included in this study. Capillary refilling time (CRT, mean value) in healthy neonates was 2.22, 2.21, 2.23, and 2.21 seconds on day1, day3, day5, and day7 of life respectively with stop watch using technique specified above. The value of CRT was found to significantly lower in low birth weight group (p-value <0.005). Babies on radiant warmer and phototherapy had low CRT values as compared with babies who are not kept under warmer or phototherapy [Table/Fig-1]. Other determinants like gender (p-value 0.919), gestational age (p-value 0.209), axillary temperature (p-value 0.144) and neonatal hyperbilirubinaemia (p-value 0.243) were not found to significantly affect CRT values. The overall upper most value of CRT was 3.42 seconds with the lowest value being 1 second. [Table/Fig-2] shows the mean, median and range of CRT on different days of life in first week.

## DISCUSSION

Our study is unique because we have measured CRT multiple times (four times) within first week of life. None of the studies have followed neonates so frequently and also range has not been established. We have tried to standardize the technique of recording CRT by using stop watch (measuring up to tenth of second). The finding of present study demonstrates that low birth weight babies have low CRT values which have not been reported so far. This may be clinically significant. Low birth weight neonates may be in shock even with normal value of CRT.

The observation of present study revealed that mean CRT value in healthy neonates was less than 3 seconds during first 7 days of life. Our findings are in broad agreement with reported studies [8,9]. CRT values were found to be low in low birth weight babies (<2500 grams) as compared to normal birth weight babies. This may be due to the fact that low birth weight infants are better clothed and covered as we take more thermal care of low birth weight babies for hypothermia.

CRT day 1 (n = 627)	Mean ± S.D	2.22 ± 0.38 (n=627)
	Median	2.20
	Range	1.00-3.34
CRT day 3 (n=371)	Mean ± SD	2.21 ± 0.36 (n=371)
	Median	2.19
	Range	1.00-3.41
CRT day 5 (n= 278)	Mean ±SD	2.23± 0.37 (n=278)
	Median	2.13
	Range	1.00-3.42
CRT day 7 (n= 248)	Mean ±SD	2.21 ± 0.33 (n= 248)
	Median	2.22
	Range	1.00-3.36

**[Table/Fig-2]:** Mean (± standard deviation), median and range of Capillary refilling time (CRT in seconds) of healthy neonates during first week of life

In healthy neonates on day 5 and day 7 of life, capillary refilling time (CRT) was noted lower in babies receiving phototherapy for jaundice as compared to rest again may be due to the fact that phototherapy increases skin temperature. This leads to increased skin blood flow [1].

CRT decreased with increasing temperature. There was no effect of gender on CRT values as also reported earlier [9,10]. Also, it is not affected by age of neonate and gestation.

## LIMITATIONS

We have not assessed inter observer variations and effect of ambient temperature, not compared CRT values in healthy neonates with sick neonates in shock. We could have compared CRT with blood pressure or oxygen saturation with pulse oxymeter.

Further studies are necessary to assess the reliability & validity of CRT as a useful tool to measure perfusion in neonates, including inter observer variation, effect of ambient temperature of CRT values etc.

## CONCLUSION

Present study highlights that CRT alone in neonatal age is less informative haemodynamic parameter; it should be evaluated along with either blood pressure or oxygen saturation with pulse oxymeter.

Low birth weight neonates have lower capillary refilling time values as compared with babies weighing more than 2500 grams.

## REFERENCES

- [1] Raju N, Venkata R, Jeffrey M, Elizabeth K, Laura SW. Capillary Refill Time in the Hands and Feet of Normal Newborn Infants. *Clinical Pediatrics*. 1999;38:139-44.
- [2] Pandey A, John BM. Capillary refill time. Is it time to fill the gaps? *Med J Armed Forces India*. 2013;69(1):97-98.
- [3] Gorelick MH, Shaw KN, Baker MD. Effect of ambient temperature on capillary refill in healthy children. *Pediatrics*. 1993;92(5):699-702.
- [4] Buerger L. Circulatory disturbances of the extremities. Philadelphia: WB Saunders; 1924:162-168.
- [5] Beecher HK, Simeone FA, Burnett CH, Shapiro SL, Sullivan ER, Mallory TB. The internal state of the severely wounded man on entry to the most forward hospital. *Surgery*. 1947;22(4):672-711.
- [6] Schriger DL, Baraff LJ. Determination and comparison of normal capillary refill between healthy children and adults. *Pediatrics Res*. 1988;23:236.
- [7] Champion HR, Sacco WJ, Carnazzo AJ, Copes W, Fouty WJ. Trauma score. *Crit Care Med*. 1981;9(9):672-76.
- [8] McGee SR, Boyko EJ. Physical examination and chronic lower-extremity ischemia: a critical review. *Arch Intern Med*. 1998;158:1357-64.
- [9] Strozik K. Capillary refilling time in Newborn babies: Normal values. *Arch Disease Child and Neonatal Edition*. 1997;76:193-96.
- [10] Raichur DV, Aralihond AP, Kasturi AV, Patil DH. Capillary refill time in term neonates: bedside assessment. *Indian J Pediatr*. 2001;68(7):613-15.

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