

## Special Article - Hemoglobin

# The Role of Red Cell Index on Cardiac Factors for Shock Patients

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## Editorial

The Red Blood Cells (RBCs) are acquainted as erythrocytes. The normal size of RBCs usually lies between 80 and 100fL. Practically, Red Cell Index (RCI) is a blood trail, which provides information about the hemoglobin content & Red Blood Size (RBS) Mean Corpuscular Volume (MCV), while MCV explains the average Red Blood Cell Size (RBCS), which is calculated by dividing the Hematocrit (HCT) by the red cell count [1-4]. Many research articles have reported as effective predictors of cardiac disease treating, RCI associated with HCT & MCV, Blood Plasma Volume (BPV), and White Blood Cells (WBC), along with its subtypes such as lymphocytes, monocytes, and neutrophils [1,4-6]. The following queries are examined in the current report.

- Is there any association of RCI with some cardiac factors for shock patients?
- If it is affirmative, what are the associations?
- What are the effects of RCI on cardiac factors?

These queries are studied in the report with the help of a real data set of 113 shock patients containing 20 characters, which is given in: <http://www.umass.edu/statdata/statdata/data/shock.txt> and the patient population and data collection method are well described in [7]. For ready reference, the 20 study characters are reported as follows.

- Age,
- Sex (male=0, female=1),
- Height,
- Systolic Blood Pressure (SBP),
- Shock Type (Shock) (non-shock=1, hypovolemic=2, cardiogenic, or bacterial, or neurogenic or other=3),
- Diastolic Blood Pressure (DBP),
- Survival Status (SURVIV) (survived=1, death=2),
- Heart Rate (HR),

- Hematocrit (HCT),
- Hemoglobin (HG),
- Plasma Volume Index (PVI),
- Cardiac Index (CI),
- Appearance Time (AT),
- Mean Arterial Pressure (MAP),
- Urinary Output (UO),
- Mean Central Venous Pressure (MCVP),
- Mean Circulation Time (MCT),
- RCI,
- Body Surface Index (BSI),
- Card Record Order (initial=1, final=2) (CRO).

The above data set contains seven cardiac factors such as DBP, SBP, MAP, HR, MCVP, CI and shock type. The above queries should be examined in two ways such as modeling of a cardiac factor on RCI, along with the remaining others, and also modeling of RCI on all the cardiac factors, along with the remaining others. Note that DBP, SBP, MAP, HR, MCVP, CI are all continuous variables, while shock type is an attribute character.

**Table 1:** Results for mean and dispersion models of RCI from Log-normal fit.

Model	Covariate	Estimate	Standard error	t-value	P-Value
Mean	Constant	2.0914	0.205171	10.193	<0.0001
	Age	0.0011	0.000922	1.1861	0.2369
	Shock2	-0.0689	0.035321	-1.9522	0.0522
	Shock3	-0.0156	0.039741	-0.3942	0.6939
	BSI	-0.1877	0.085501	-2.1962	0.0291
	PVI	0.0066	0.001142	5.7462	<0.0001
	HG	0.0325	0.012541	2.5882	0.0103
	HCT	0.0148	0.004161	3.5613	0.0004
Dispersion	Constant	3.724	2.11931	1.7571	0.0804
	Height	-0.0282	0.01262	-2.2403	0.0261
	Shock2	-0.1284	0.29661	-0.4332	0.6654
	Shock3	0.5488	0.31011	1.7691	0.0783
	SBP	0.0051	0.00371	1.3581	0.1758
	CI	-0.1796	0.08682	-2.0692	0.0397
	UO	-0.0014	0.00092	-1.5601	0.1202
	PVI	-0.014	0.00812	-1.7303	0.085
	HCT	-0.0398	0.01492	-2.6612	0.0083

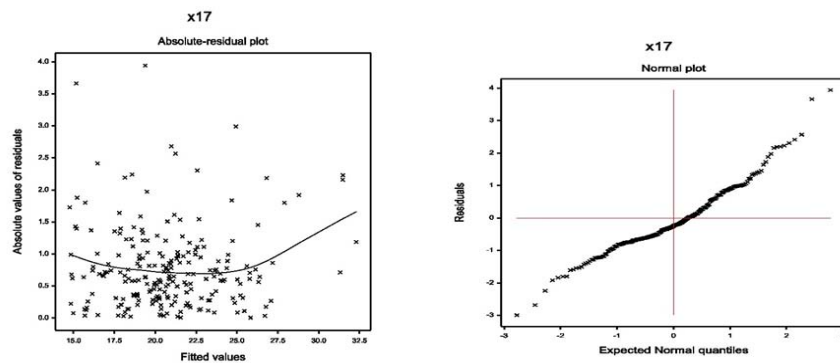


Fig. 1(a)

Fig. 1(b)

**Figure 1:** For the RCI fitted Log-normal fitted models (Table 1) the (a) absolute residuals plot with respect fitted values, and (b) normal probability plot for the mean model.

Let us examine the RCI modeling on all the cardiac factors, along with the remaining other variables. Here all the continuous variables are positive, heterogeneous, continuous and non-normally distributed. These are modeled using Joint Generalized Linear Models (JGLMs) under both the Log-normal & Gamma distributions [8-10]. Log-normal JGLMs fit of RCI is better than the Gamma, which is shown in Table 1, and its fit verification is displayed in Figure 1. Figure 1(a) shows the absolute residuals plot against the predicted RCI values, which is approximately a flat straight line, concluding that variance is constant with the running means. On the hand, Figure 1(b) shows the normal probability plot of mean RCI Log-normal fitted model in Table 1. Both the plots do not reveal any fit discrepancy. Therefore, Log-normal fitted RCI model (Table 1) is approximately a very close to its true model. RCI mean & dispersion models are as follows.

Mean = =Log(RCI) = 2.0914 + 0.0011Age - 0.0689Shock2 - 0.0156 Shock3 - 0.1877BSI + 0.0066PVI + 0.0325HG + 0.0148HCT, and

Dispersion = = exp(3.7240 - 0.0282Height - 0.1284Shock2 + 0.5488Shock3 + 0.0051SBP -0.1796CI - 0.0014UO - 0.0140PVI - 0.0398HCT).

From Table 1, and the above mean & dispersion models, the following associations of RCI with cardiac factors can be intimated.

- Mean RCI level is inversely associated with shock type at level Shock2 (P=0.0522), indicating that as RCI level decreases, incidence of shock will be increased of the shock patients at level Shock2 than the non-shock patients at level Shock1.
- Variance of RCI level is inversely associated with CI (P=0.0397), concluding that it increases as CI decreases.
- RCI level variance is directly associated with shock type at level Shock3 (P=0.0783), indicating that it increases for the shock patients at higher level shock3, than the other patients.
- RCI level variance is directly partially associated with SBI (P=0.1758), interpreting that it increases as SBI increases. Note that in epidemiology, partially significant effect is treated as confounder in the model.

The above associations of RCI level with cardiac factors (shock

**Table 2:** Association of Cardiac factors (MCVP, MAP, HR) with RCI.

Model	Response Variable	Associated with	Estimate	S.E.	t-value	P-value
Mean	MCVP	RCI	0.0020	0.0020	1.010	0.3155
Variance	MCVP	RCI	-0.0340	0.0143	-2.377	0.0183
Mean	MAP	RCI	-0.0008	0.0004	-1.883	0.0610
Variance	HR	RCI	0.0420	0.0216	1.963	0.0509

type, CI & SBP) are derived from its mean and variance models.

On the other hand, the associations of a cardiac factor (such as MCVP, MAP, HR, SBP, DBP and CI) with RCI level can be examined from its respective JGLMs. From the JGLMs of MCVP, MAP and HR, which are given in [11-13], the following associations, can be concluded.

- MCVP is directly partially associated with RCI (P=0.3155), interpreting that MCVP rises as RCI increases [11]. Here RCI is a confounder.
- Variance of MCVP level is inversely associated with RCI (P=0.0183), concluding that it increases as RCI decreases [11].
- MAP is inversely associated with RCI (P=0.0610), implying that it increases as RCI decreases [12].
- Variance of heart rate is directly associated with RCI (P=0.0509), indicating that that it increases as RCI increases [13].

The summarized form of the above associations of RCI is displayed in Table 2. JGLMs of SBP, DBP, CI do not show any association with RCI [14,15].

The report has focused the associations of RCI level with many cardiac factors such as shock-type, CI, MCVP, MAP, HR and SBP. Any association of RCI with DBP is not shown in the report. Further studies may give more information. It is found herein that RCI is associated with shock type. Its low level invites shock (Table 1). The reasons of shock and variation of other cardiac factors such as CI, MCVP, MAP, HR and SBP can be explained with the predictor RCI level. Researchers and medical practitioners can be benefitted from the report. Shock patients should care on the RCI level regularly.

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