EC CARDIOLOGY
Editorial

Impact of Hemoglobin on Cardiac Parameters for Shock Patients

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A principal cause of death worldwide is cardiovascular disease (CVD). If the present CVD death trend continues, the predicted deaths throughout the world due to CVD is approximately 25 million by 2020 [1,2]. So, it is very important to locate the all possible cardiovascular risk and protective factors. CVD deaths can be reduced if people should control the risk factors, and try to improve the protective factors. Many articles have shown the association between hemoglobin and cardiac diseases [3-6]. It is noted that hemoglobin level may affect the cardiovascular system through blood viscosity and oxygen supply [7,8]. But there is a little study regarding the association of hemoglobin concentration (HGC) with the cardiac parameters. Generally, the following queries arise:

- How do we identify the association between HGC and any cardiac parameter?
- Does HGC effect on heart rate (HR), or systolic blood pressure (SBP), or mean arterial pressure (MAP), or diastolic blood pres sure (DBP), or mean central venous pressure (MCVP), or cardiac index (CI)?
- What are the associations of hemoglobin concentration with these cardiac parameters?
- What will happen on these cardiac parameters if HGC is high or low?
- What are the explanatory factors of HGC?
- How do we increase or decrease HGC?

These issues are examined herein with a real data set of 113 shock patients along with 20 study characters, and the data is displayed in the site: http://www.umass.edu/statdata/statdata/data/shock.txt. The present study characters/variables are [9]:

- Sex (SEX) (male = 0, female = 1),
- Age (AGE),
- Height (HEIGHT),
- SBP,
- Shock type (SHOCKT) (non-shock = 1, hypovolemic = 2, cardiogenic, or bacterial, or neurogenic or other = 3),
- DBP,
- Survival status (SURVIV) (survived = 1, death = 2),
- HR,
- Hematocrit (HCT)
- HGC,
- Plasma volume index (PVI),
- CI,
- Appearance time (AT),
- MAP,
- Urinary output (UO),
- MCVP,
- Mean circulation time (MCT),
- Red cell index (RCI),
- Body surface index (BSI),
- Card record order (initial = 1, final = 2) (CRO).

In the above data set, there are only six cardiac parameters such as SBP, MAP, DBP, MCVP, HR and CI. First query is: How do we identify the association between HGC and anyone of the above cardiac parameter? The association between HGC and any cardiac parameter can be examined in two ways. The first is based on an appropriate model of any cardiac parameter (response variable) on HGC along with the rest explanatory variables. The second is based on the model of HGC on all the cardiac parameters along with the rest variables. Note that all these seven responses such as HGC, SBP, MAP, DBP, MCVP, HR and CI are continuous, heteroscedastic, positive and non-normally distributed, which may be properly modeled by joint generalized liner models (JGLMs) under Log-normal and Gamma models, and JGLMs are clearly described in [10-12]. Models of the cardiac parameters (SBP, MAP, DBP, MCVP, HR and CI) are given partly or fully in [13-17]. Based on these models (first method) the association between HGC and any cardiac parameter is reported as follow:

- Mean CI is negatively associated with HGC (P = 0.0053), concluding that CI rises as HGC decreases, while variance of CI has no association with HGC [13].
- Mean SBP is negatively associated with HGC (0.0051), interpreting that SBP rises as HGC decreases, while variance of SBP has no association with HGC [14].
- Mean DBP is positively associated with HGC (0.0773), indicating that DBP rises as HGC rises, while variance of DBP has no association with HGC [14].
- Mean HR has no association with HGC, while variance of HR is positively associated with HGC (0.0559), implying that HR variance rises as HGC increases [15].
- Mean MCVP has no association with HGC, while variance of MCVP is positively associated with HGC (0.0008), interpreting that MCVP variance rises as HGC rises [16].
- Both mean and variance of MAP have no association with HGC [17].

The above associations between HGC and cardiac parameters are displayed in table 1. Based on the first way, the answer of the 2nd, 3rd and 4th queries are partly given in above. Now the answers are examined according to the second way.

Variable	Association type with HGC	P-value
Mean CI	Negative	0.0053
Variance of CI	Nil	-----
Mean SBP	Negative	0.0051
Variance of SBP	Nil	-----
Mean DBP	Positive	0.0773
Variance of DBP	Nil	-----
Mean HR	Nil	-----
Variance of HR	Positive	0.0559
Mean MCVP	Nil	-----
Variance of MCVP	Positive	0.0008
Mean MAP	Nil	-----
Variance of MAP	Nil	-----

Table 1: *Association of cardiac parameters with hemoglobin concentration (HGC) level.*

The second way is based on the model of HGC for the given data [9], which has not been reported in any previous article. Here the JGLMs analysis of HGC under Log-normal distribution is displayed in table 2. Model checking plots namely absolute residuals plot against the fitted values, and normal probability plot for the fitted mean model (Table 2) are shown in figure 1a and figure 1b respectively, which do not show any lack of fit. Based on the mean and variance models of HGC (Table 2), the association between HGC and any cardiac parameter is reported as follow:

Model	Covariate	Estimate	Standard error	t-value	P-Value
Mean Model	Constant	1.5961	0.029371	54.34	< 0.0001
	SURVIVE (Fx4;2)	-0.0178	0.013029	-1.36	0.1752
	Mean central venous pressure (MCVP) (x 10)	-0.0019	0.001122	-1.69	0.0924
	Appearance time (AP) (x 13)	0.0015	0.001224	1.23	0.2200
	Hematocrit (HCT) (x 19)	0.0240	0.000808	29.71	< 0.0001
Dispersion Model	Constant	-0.8350	0.6800	-1.228	0.2221
	SEX (Fx3;2)	-0.5595	0.2206	-2.537	0.0118
	SHOCKT (Fx5:2)	0.3716	0.2744	1.354	0.1771
	SHOCKT(Fx5;3)	-0.3894	0.3029	-1.286	0.1998
	Systolic blood pressure (SBP)(x6)	-0.0123	0.0031	-3.922	0.0001
	Hear rate (HR) (x8)	0.0074	0.0042	1.778	0.0768
	Mean central venous pressure (MCVP) (x 10)	0.0420	0.0229	1.834	0.0679
	Cardiac index (CI) (x12)	-0.1374	0.0749	-1.835	0.0678
	Urinary output (UO) (x15)	0.0018	0.0009	1.978	0.0492
	Hematocrit (HCT) (x19)	-0.0934	0.0156	-5.982	< 0.0001

Table 2: *Results for mean and dispersion models of hemoglobin level from Log normal fit.*

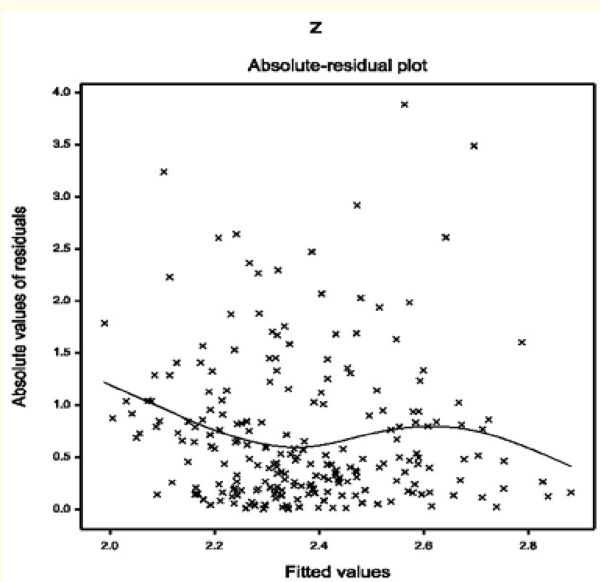

Figure 1a: *HGC Residual plot.*

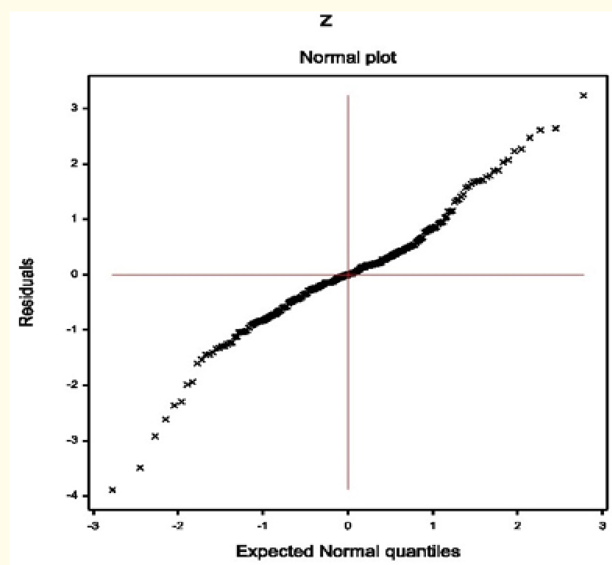

Figure 1a: *HGC Normal probability plot.*

Figure 1: *For the joint Log-normal fitted models of HGC (Table 2), the (a) absolute residuals plot with respect to the fitted values, and (b) the normal probability plot for the mean model.*

- Mean HGC is negatively associated with MCVP (P = 0.0924), concluding that MCVP rises, as HGC decreases.
- Variance of HGC is negatively associated with SBP (P = 0.0001), interpreting that HGC variance rises, as SBP decreases.
- Variance of HGC is negatively associated with CI (P = 0.0678), concluding that HGC variance rises, as CI decreases.
- Variance of HGC is positively associated with HR (P = 0.0768), indicating that HGC variance rises, as HR increases.
- Variance of HGC is positively associated with MCVP (P = 0.0679), implying that HGC variance rises, as MCVP increases.

Note that the above first three associations are not derived in the first method (Table 1). The last two associations are similar to the first method. Based on the second way, the answer of the 2nd, 3rd and 4th queries are partly given in above. The answer of the 5th query (what are the explanatory factors of HGC?) is given in table 2. Note that HGC is highly positively associated with hematocrit (HCT) (P < 0.0001) (Table 2), indicating that HGC increases or decreases according as HCT increases or decreases. Therefore, answer of the 6th query (how do we increase or decrease HGC?) is also given in table 2. All the above six queries are reported partially herein based on statistical analysis. There may be many more information regarding the above six queries. Hope that future researches may focus more. Even though it is an Editorial note, yet all queries in the report have been presented herein based on statistical data analysis.

The report has focused some impacts of HGC on cardiac parameters. In practice, medical practitioners always try to control the cardiac parameters (SBP, DBP, MAP, MCVP, HR, CI) of the patients under treatment. Clinical practitioners always try to increase mean CI and HR, and try to control mean values of SBP, DBP, MAP and MCVP. In addition, practitioners also try to decrease the variance of each cardiac parameters. From table 1, it is noted that if HGC is low, mean CI and SBP are high, while mean DBP is low, and variances of MCVP and HR are also low. These conditions of a patient are more desirable to the medical practitioners. Note that HGC should not be too low, otherwise mean SBP will be very high. From table 2, it is noted that if HGC is low, mean MCVP is high (partially significant), and variance of HGC is low if HR and MCVP are low (partially significant), and SBP and CI (partially significant) are high. The report focuses many impacts HGC on cardiac parameters, and its level should not be very high and very low also. Medical practitioners should care on hemoglobin concentration level of cardiac patients.

Conflict of Interest

The authors confirm that this article content has no conflict of interest.

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