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Hypertension Risk Factors of Shock Patients

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Abstract

This article focuses the hypertension risk factors of shock patients, based on the data set in Shock Research Unit at the University of Southern California, Los Angeles, California. The risk factors of systolic blood pressure, diastolic blood pressure, and mean arterial pressure are discussed for the awareness of the healthy individuals, shock patients and medical practitioners.

Keywords: Blood pressure; Coronary heart disease; Gamma model; Heart rate; Mean arterial pressure; Non-constant variance

Hypertension Risk Factors

Blood pressure and hypertension are commonly associated with each other. Hypertension is associated with stroke for 54%, and 47% of ischaemic heart disease and it affects 30% of the adult population [1,2]. Despite the availability of numerous drugs, response rates to any given drug are approximately 50% and only one in three patients with hypertension has their blood pressure controlled to target [3]. Several studies have shown that up to 53% of patients with uncontrolled hypertension were non-adherent to treatments [4,5]. Many factors (sleep apnoea, lifestyle, biochemical parameters, etc.) are responsible for uncontrolled blood pressure, and the intra-individual blood pressure variability and the genetic effects have a major impact on the determination of response to drugs [6,7]. Little is known in the literature about the hypertension risk factors for the patients who underwent shocked.

We seek answers to the following questions: What are the causal factors of systolic, diastolic blood pressures and mean arterial pressure? How the risk factors are associated with the hypertension markers (systolic, diastolic blood pressures, and mean arterial pressure)? What are the effects of the risk factors on these markers? These answers are examined based on the data set of 21 variables on 113 subjects, collected at the Shock Research Unit at the University of Southern California, Los Angeles, California. Initial measurements (measurements upon admission) and final measurements on the same variables (measurements just before death or discharge) were collected on 113 critically ill patients. A detailed description of the data set, collection method, patient population and the shocks types are given in [8].

The variables/factors (excluding identification number) of this study are Age (years) (coded as AGE), Height (cm) (coded as HT), Sex (male=1, female 2) (coded as SEX), Survival (survived=1, death=2) (coded as SURVIVE), Shock type (non-shock=1, hypovolemic=2, cardiogenic=3, bacterial=4, neurogenic=5, other=6) (coded as SHOCK), Systolic blood pressure (mm Hg) (coded as SBP), Mean arterial blood pressure (mm Hg) (coded as MAP), Heart rate (beats/min) (coded as HR), Diastolic blood pressure (mm Hg) (coded as DBP), Mean central venous pressure (cm H_2O) (coded as MCVP), Body surface index (m^2) (coded as BSI), Cardiac index (liters/min m^2) (coded as CI), Appearance time (s) (coded as AT), Mean circulation time (sec) (coded as MCT), Urinary output (ml/h) (coded as UO), Plasma volume index (ml/kg) (coded as PVI), Red cell index (ml/kg) (coded as RCI), Hemoglobin (g/100 ml) (coded as HG), Hematocrit (percent) (coded as HCT), Card sequence (none) (initial=1, final=2) (coded as RECORD). This data set has been analyzed by both the joint Log-normal and Gamma models [9]. In each case, Gamma models fit gives better results. The risk factors of the hypertension markers (systolic blood pressure, diastolic blood pressure, and mean arterial blood pressure) are as follows.

Systolic blood pressure (SBP) has been modeled based on the remaining other variables/factors using the joint Gamma models. The results are as follows. The mean SBP is separately negatively associated with HT (P<0.001), SURVIVE (P=0.023), DBP (P<0.001) and HG (P=0.005). These indicate that the mental patients with low HT or DBP or HG have high SBP. Also the mental patients who survived have high SBP. On the other hand, the mean SBP is separately positively associated with SEX (P=0.013), MAP (P<0.001), HR (P=0.004), BSI (P=0.003), and AT (P=0.004). The mean SBP is higher for female mental patients than male. If at least any one of MAP, HR, BSI, AT is high, the mean SBP is high. The variance of SBP is separately negatively associated with SHOCK (P<0.001), MAP (P<0.001), BSI (P=0.086) and CI (P=0.080). So, SBP variance is high if MAP or BSI or CI is low. The mental patients with non-shock have high SBP variance. It implies that SBP variance is highly scattered for non-shock patients than the shocked patients. Again the SBP variance is separately positively associated with AGE (P=0.064), HT (P=0.022), HR (P=0.052) and MCVP (P=0.001). So, the SBP variance is high if at least any one of AGE, HT, HR, and MCVP is high.

Diastolic blood pressure (DBP) has been modeled based on the remaining other variables/factors using the joint Gamma models. The identified risk factors of DBP are as follows. The mean DBP is separately negatively associated with SURVIVE (P=0.009), SBP (P<0.001), PVI (P=0.069) and RECORD (P<0.001). If SBP or PVI is low, DBP is high. The mental patients at the initial stage have higher DBP than the final stage, and the patients who survived have higher DBP than those who were close to death. The mean DBP is separately positively associated with AGE (P=0.081), MAP (P<0.001), HR (P<0.001), AT (P=0.043), HG (P=0.077) and HCT (P=0.297) (a confounder). So, the mean DBP is high at older age, at high value of MAP, HR, AT, HG and HCT. The variance of DBP is separately negatively associated with CI (P<0.001) and MCT (P=0.012). If CI or MCT is low, DBP variance is high. Again the DBP variance is separately positively associated with AGE

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Response	Associated with	Association type	P-value
Mean systolic blood pressure (SBP)	Height (HT)	negative	P<0.001
	SURVIVE	negative	P=0.023
	Diastolic BP (DBP)	negative	P<0.001
	Hemoglobin (HG)	negative	P=0.005
	SEX	positive	P=0.013
	Mean arterial blood pressure (MAP)	positive	P<0.001
	Heart rate (HR)	positive	P=0.004
	Body surface index (BSI)	positive	P=0.003
	Appearance time (AT)	positive	P=0.004
Variance of SBP	SHOCK	negative	P<0.001
	Mean arterial blood pressure (MAP)	negative	P<0.001
	Body surface index (BSI)	negative	P=0.086
	Cardiac index (CI)	negative	P=0.080
	AGE	positive	P=0.064
	Height (HT)	positive	P=0.022
	Heart rate (HR)	positive	P=0.052
	Mean central venous pressure (MCVP)	positive	P=0.001
Mean diastolic blood pressure (DBP)	SURVIVE	negative	P=0.009
	Systolic blood pressure (SBP)	negative	P<0.001
	Plasma volume index (PVI)	negative	P=0.069
	RECORD	negative	P<0.001
	AGE	positive	P=0.081
	Mean arterial blood pressure (MAP)	positive	P<0.001
	Heart rate (HR)	positive	P<0.001
	Appearance time (AT)	positive	P=0.043
	Hemoglobin (HG)	positive	P=0.077
	Hematocrit (HCT)	positive	P=0.297
Variance of DBP	Cardiac index (CI)	negative	P<0.001
	Mean circulation time (MCT)	negative	P=0.012
	AGE	positive	P<0.001
	Height (HT)	positive	P<0.001
	SEX	positive	P=0.092
	Plasma volume index (PVI)	positive	P<0.001
Mean arterial blood pressure (MAP)	SURVIVE	negative	P=0.002
	Heart rate (HR)	negative	P<0.001
	Body surface index (BSI)	negative	P<0.001
	Appearance time (AT)	negative	P=0.010
	Red cell index (RCI)	negative	P=0.061
	AGE	positive	P=0.020
	SHOCK	positive	P=0.054
	Systolic BP (SBP)	positive	P<0.001
	Diastolic BP (DBP)	positive	P<0.001
	Mean central venous pressure (MCVP)	positive	P=0.023
	Cardiac index (CI)	positive	P=0.001
	Urinary output (UO)	positive	P=0.036
	Hematocrit (HCT)	positive	P=0.081
	RECORD	positive	P=0.049
Variance of MAP	SEX	negative	P=0.002
	SHOCK	negative	P<0.001
	Systolic BP (SBP)	negative	P<0.001
	Body surface index (BSI)	negative	P=0.009
	Cardiac index (CI)	negative	P=0.009
	SURVIVE	positive	P<0.001

Table 1: Association of different blood pressures with different risk factors.

(P<0.001), HT (P<0.001), SEX (P=0.092) and PVI (P<0.001). So, DBP variance is high at older age, or at high value of HT or PVI.

Mean arterial blood pressure (MAP) has been modeled based on the remaining other variables/factors using the joint Gamma models. The identified risk factors of MAP are as follows. The MAP is separately negatively associated with SURVIVE (P= 0.002), HR (P<0.001), BSI (P<0.001), AT (P=0.010) and RCI (P=0.061). Therefore, MAP is high at low HR or BSI or AT or RCI. Also the patients have higher MAP who survived than the patients who were close to death. Again the MAP is separately positively associated with AGE (P=0.020), SHOCK (P=0.054), SBP (P<0.001), DBP (P<0.001), MCVP (P=0.023), CI (P=0.001), UO (P=0.036). HCT (P=0.081) and RECORD (P=0.049). So, the MAP is high if at least any one of AGE, SBP, DBP, MCVP, CI, UO, HCT is high.

Also the MAP is higher for the patients with shock levels at bacterial or neurogenic or other than the non-shock or hypovolemic or cardiogenic. Again, the MAP is higher of the patients at final stage than the initial stage. The MAP variance is separately negatively associated with SEX (P=0.002), SHOCK (P<0.001), SBP (P<0.001), BSI (P=0.009) and CI (P=0.009). Thus, the MAP variance is high at low value of SBP or BSI or CI. The MAP variance is higher for male patients than female, and it is also higher for non-shocked patients than the shocked. It indicates that MAP variance is more stable for the shocked patients than the non-shocked. Also, the MAP variance is positively associated with SURVIVE (P<0.001). So, the MAP variance is higher for the patients who were close to death.

All the results as described above are summarized in Table 1. The above results are derived based on joint Gamma models [9]. Here the mean and variance parameters of the responses (systolic, diastolic and mean arterial blood pressures) are very shortly discussed. All the derivations along with many other confounded parameters will be discussed in the full research papers. The complete research papers will be submitted very soon. The above mentioned hypertension risk factors are associated with mental patients. This report recommends the following for all individuals. Care should be taken for blood pressures at older ages. Male individuals have higher hypertension risk than females. Blood pressures and heart rates are highly associated. Shock types are highly associated with the blood pressures. Medical practitioners should be care on shock types, and the other risk factors. For better medical treatment, shocks to be reduced, and the other risk factors should be considered by the medical practitioners.

Conflict of Interest

The author confirms that this article content has no conflict of interest.

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