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Commentary

The Mean Arterial Blood Pressure Determinants

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In medical science (or in medicine), the mean arterial blood pressure (MABP) is used to present an average blood pressure in an individual [1]. During a single cardiac cycle, the average arterial pressure is known as the MABP. It is not a directly measurable quantity. It is calculated from the formula which is given by MABP = Cardiac output (CO) × systemic vascular resistance (SVR) + Central venous pressure (CVP). Note that SVR = (Mean Arterial Pressure - Mean Venous Pressure)/Cardiac output [2]. At normal resting heart rates, MABP can be approximately estimated using the easily measured quantity such as systolic blood pressure (SBP) and diastolic blood pressure (DBP) as given by MABP ≈ (2DBP +SBP)/3 [3]. Note that MABP is treated to be the perfusion pressure which is seen by organs in the body. It is known that the MABP is greater than 60 mmHg is sufficient to sustain the organs of the average persons. Note that normally MABP lies between 70 to 110 mmHg [4]. If the MABP falls significantly below 60 mmHg for an appreciable time, the end organ will not get sufficient blood flow, and will become ischemic. The current report focuses the following hypotheses related to MABP. For a certain group of patients, what are the determinants of MABP? How are the determinants correlated with the MABP? What are the effects of the determinants on MABP? Knowledge of these speculations are little known in the heart disease literature. The above hypotheses are examined in the present report based on a real data set in [5].

The considered data set can be found in the site: http://www.umass.edu/statdata/statdata/data/shock.txt and, the shock types, patient population, and data collection method are clearly described in [5]. The Shock Research Unit, The University of Southern California, Los Angeles, California has collected this data set on 113 shock patients with 20 variables/factors. Two measurements were taken on each study unit. First measurement was taken at the admission time, and the second one was taken at the discharge time or just before death. The data set includes 20 attribute characters/ variables which are age, height, sex (male = 0, female = 1), diastolic blood pressure (DBP), systolic blood pressure (SBP), mean central venous pressure (MCVP), mean arterial blood pressure (MABP), heart rate (HR), mean circulation time (MCT), cardiac index (CI), body surface index (BSI), shock type (non-shock = 1, hypovolemic = 2, cardiogenic, or bacterial, or neurogenic or other = 3), plasma volume index (PVI), urinary output (UO), hematocrit (HCT), appearance time (AT), hemoglobin (HG), red cell index (RCI), survival stage (survived = 1, death = 2), order of card record (initial = 1, final = 2) (OCR).

The above shock data set includes mean arterial blood pressure (MABP), which is considered as the dependent variable, and the remaining others are treated as the explanatory variables. Note that the response MABP is positive with non-constant variance, and its distribution may belong to exponential family distribution. Therefore, the response MABP should be analyzed using both the Log-normal and gamma joint generalized linear models [6]. We have examined the response MABP using both the models. For the MABP analysis, it is found that the joint gamma models fit (Akaike information criterion (AIC) value = 1368.807) is better than the Log-normal fit (AIC = 1381). The fitted joint gamma models of MABP interpret the following for the considered hypotheses in the present note.

- The mean arterial blood pressure (MABP) is positively correlated with the age ($P < 0.020$), indicating that MABP is higher at older ages than younger ages.
- The MABP is negatively associated with the survival stage (survived = 1, death = 2) ($P = 0.002$), indicating that MABP is higher of the survived patients than the patients near to death.
- The MABP is positively correlated with the shock type (non-shock = 1, hypovolemic = 2, cardiogenic, or bacterial, or neurogenic or other = 3) ($P = 0.054$), indicating that MABP is higher of the shock patients with shock levels at cardiogenic, or bacterial, or neurogenic or other = 3, than the other levels.
- The MABP is positively correlated with the systolic blood pressure (SBP) ($P< 0.001$), indicating that MABP increases as the SBP increases. Note that MABP is a direct linear function of SBP (as MABP ≈ (2DBP +SBP)/3).
- The MABP is negatively correlated with the heart rate (HR) ($P < 0.001$), indicating that MABP decreases as the HR increases.
- The MABP is positively correlated with the diastolic blood pressure (DBP) ($P < 0.001$), indicating that MABP increases as the DBP increases. Note that MABP is a direct linear function of DBP (as MABP ≈ (2DBP +SBP)/3).
- The MABP is positively correlated with the mean central venous pressure (MCVP) ($P = 0.023$), indicating that MABP increases as the MCVP increases.
- The MABP is negatively correlated with the body surface index (BSI) ($P < 0.001$), indicating that MABP increases as the BSI decreases.
- The MABP is positively correlated with the cardiac index (CI) ($P = 0.001$), indicating that MABP increases as the CI increases.
- The MABP is negatively correlated with the appearance time (AT) ($P = 0.010$), indicating that MABP increases as the AT decreases.
- The MABP is positively correlated with the urinary output (UO) ($P = 0.036$), indicating that MABP increases as the UO increases.
- The MABP is negatively correlated with the red cell index (RCI), ($P = 0.061$), indicating that MABP increases as the RCI decreases.
- The MABP is positively correlated with the hematocrit (HCT) ($P = 0.081$), indicating that MABP increases as the HCT increases.
- The MABP is positively correlated with the order of card record (initial = 1, final = 2) (OCR) ($P = 0.049$), indicating that MABP is higher of the shock patients at the final stage of the card than the initial stage.
- The variance of MABP is negatively correlated with the sex (male = 0, female = 1) ($P = 0.010$), indicating that the variance of MABP is higher for male than female.
- The variance of MABP is positively correlated with the survival stage (survived = 1, death = 2) ($P < 0.001$), indicating that the variance of MABP is higher for the shock patients who are close to death than the survived patients.
- The variance of MABP is negatively correlated with the shock type (non-shock = 1, hypovolemic = 2, cardiogenic, or bacterial, or neurogenic or other = 3) at level (hypovolemic = 2) ($P < 0.001$) and at levels (cardiogenic, or bacterial, or neurogenic or other = 3) ($P < 0.001$), indicating that the variance of MABP is higher for the non-shock patients than the shocked patients.
- The variance of MABP is negatively correlated with the systolic blood pressure (SBP) ($P < 0.001$), indicating that the variance of MABP increases as SBP decreases.
- The variance of MABP is negatively correlated with the body surface index (BSI) ($P = 0.009$), indicating that the variance of MABP increases as BSI decreases.
- The variance of MABP is negatively correlated with the cardiac index (CI) ($P = 0.009$), indicating that the variance of MABP increases as CI decreases.
- The variance of MABP is negatively partially correlated with the urinary output (UO) ($P = 0.178$), indicating that the variance of MABP increases as UO decreases.

The factors or the determinants of the mean arterial blood pressure (MABP), their associations and effects with MABP are presented above. Note that the three blood pressures, namely, systolic, diastolic and mean central venous pressures are positively associated with the MABP. In addition, these three blood pressures are directly related with the MABP. Age, shock type, cardiac index, urinary output and hematocrit are positively associated with the MABP. On the other hand, survival status, heart rate, body surface index, appearance time, red cell index are negatively associated with the MABP. The variance of MABP is negatively associated with the shock type, systolic blood pressure, body surface index, cardiac index, and urinary output, while it is only positively associated with the survival status. It is observed that many factors are associated with the variance and mean of arterial blood pressure. Cardiac patients, researchers and cardiologists will be benefited from the above findings. Future cardiac researchers are advised to consider the additional explanatory variables such as maximum blood pressure, basal blood pressure, peak, basal & maximum heart rates, body mass index, ejection fraction etc., in order to explain the mean arterial blood pressure.

Conflict of Interest

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

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