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Relationship of Urinary Output with Cardiac & Biochemical Parameters of Shock Patients

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Generally, urine output is treated as an Acute Kidney Injury (AKI) marker which guides fluid resuscitation in critically ill patients. In practice, decreased urine output is correlated with decreased glomerular filtration rate due to several causes such as decrease of renal perfusion pressure, or renal blood flow, neurohormonal factors, functional changes influenced by natriuresis & diuresis in critically ill patients [1-3]. After a cardiac surgery, the most serious & potentially life-threatening complication is AKI [4-6]. An early identification of AKI makes the treatment quick, easy and mitigates the renal injury progression. Many stratification models are used to detect the early AKI risk of the patients [7-9]. An important AKI diagnostic criterion in critically ill patients is oliguria which is often applied as a real-time AKI indicator [10,11]. In addition, serum creatinine is also used as an early AKI diagnostic criterion [12].

It is noted that decreased urine output (or AKI) is a life-threatening risk factor in critically ill patients. The fundamental queries are:

- Is Urine Output (UO) correlated (or associated) with any cardiac parameters such as blood pressure (BP) (Systolic Blood Pressure (SBP), Diastolic Blood Pressure (DBP), Basal Blood Pressure (BBP), Maximum Blood Pressure (MBP), Mean Arterial Pressure (MAP), Mean Central Venous Pressure (MCVP)), Heart Rate (HR) (Basal HR (BHR), Peak HR (PHR), Maximum HR (MHR)), Cardiac Index (CI), Baseline Cardiac Ejection Fraction (BCEF) etc.?
- How are the cardiac parameters associated with UO?
- Is urine output correlated with any biochemical parameters such as Haemoglobin (HG), Haematocrit (HCT), Red Cell Index (RCI), Plasma Volume Index (PVI) etc.?
- How is the biochemical parameters associated with UO?

Based on our knowledge, the above hypotheses have been studied a little in the earlier literature. Many of the findings of the report are completely new in the literature. These above hypotheses are partially examined in the report based on a real data set of 113 shock patients, along with 20 factors/ variables [13] as the data set does not contain all the interested responses. The data set is displayed in the site: http://www.umass.edu/statdata/statdata/data/shock.txt

For ready reference, the variables and factors in the data set is reproduced herein.

The factors and variables are:

- Age (AGE)
- Height (HT)
- Sex (male=0, female=1)
- Survival stage (survived=0, death=1)
- Shock type (non-shock=1, hypovolemic=2, cardiogenic, or bacterial, or neurogenic or other=3)
- Systolic blood pressure (SBP)
- Mean arterial pressure (MAP)
- Heart rate (HR)
- Diastolic blood pressure (DBP)
- Mean central venous pressure (MCVP)
- Body Surface Index (BSI)
- Cardiac index (CI)
- Appearance time (AT)
- Mean circulation time (MCT)
- Urinary output (UO)
- Plasma volume index (PVI)
- Red cell index (RCI)
- Hemoglobin (HG)
- Hematocrit (HCT),
- Order of card record (initial=1, final =2) (OCR)

In the data set, we have only six cardiac parameters (SBP, MAP, HR, DBP, MCVP, CI) and four biochemical parameters (PVI, RCI, HG, HCT), and all the cardiac parameter analyses are given in [14-18] while biochemical parameter analyses to be appeared soon. Based on these analyses, we have the following answers of the above hypotheses.

- MCVP is negatively associated (or correlated) with UO (P=0.0121), indicating that UO decreases as MCVP increases [17].
- Variance of MCVP is positively correlated with UO (P=0.0316), indicating that variance of MCVP increases as UO increases [17].

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Model	Response	Response distribution	Estimate	Standard error	t-value	P-value
Mean	MCVP	Gamma	-0.0013	0.0005	-2.532	0.0121
Dispersion	MCVP	Gamma	0.0019	0.0009	2.163	0.0316
Mean	MAP	Gamma	0.0001	0.0001	2.113	0.0358
Dispersion	MAP	Gamma	-0.0010	0.0010	-1.350	0.1784
Dispersion	PVI	Gamma	-0.0019	0.0009	-2.180	0.0303
Dispersion	RCI	Log-normal	-0.0014	0.0009	-1.560	0.1202
Dispersion	HG	Log-normal	0.0018	0.0009	1.978	0.0492
Mean	HCT	Gamma	-0.0001	0.0001	-2.350	0.0197

Table 1: Association of UO with cardiac & biochemical parameters.

- MAP is positively correlated with UO (P=0.0358), indicating that UO increases as MAP increases [15].
- Variance of MAP is negatively correlated with UO (P=0.1784), indicating that variance of MAP increases as UO decreases [15].
- Variance of PVI is negatively correlated with UO (P=0.0303), indicating that variance of PVI increases as UO decreases.
- Variance of RCI is negatively correlated with UO (P=0.1202), indicating that variance of RCI increases as UO decreases.
- Variance of HG is positively correlated with UO (P=0.0492), indicating that variance of HG increases as UO increases.
- Mean HCT is negatively correlated with UO (P=0.0197), indicating that UO decreases as HCT increases.

Note that SBP, DBP, HR and CI have no effect on UO [14,16,18] while MCVP, MAP, PVI, RCI, HG and HCT have significant effects on UO. The above summarized results are displayed in Table 1, which shows stable parameter estimates as their standard errors are very small. From the above results, UO will be higher if the MCVP & HCT are lower, while MAP to be higher. UO will be higher, if the variance of MCVP & HG is higher, while the variance of MAP, PVI and RCI are lower. For AKI patients, clinical practitioners are required to examine the cardiac parameters MCVP & MAP and the biochemical parameters PVI, RCI, HG and HCT. Based on the reports clinical practitioners will be benefitted.

Conflict of Interest

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

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