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ORIGINAL RESEARCH ARTICLE

YOUNG AND NOVICE DONORS ARE MORE SUSCEPTIBLE TO HEMODYNAMIC ADVERSE EFFECTS DURING BLOOD DONATION

B Gorkhali[1], M Amatya[2] and P Dewan[1]

[1]Bir Hospital Nursing Campus, National Academy of Medical Sciences, Kathmandu
[2]Department of Clinical Physiology, Maharajgunj Campus, Institute of Medicine (TU), Kathmandu

Correspondence: *Dr. Mrigendra Amatya, Department of Clinical Physiology, Maharajgunj Campus, Kathmandu, e-mail: amrigendra@yahoo.com*

ABSTRACT

In mild and moderate hemorrhage, as in blood donation, decreased cardiac output is compensated by sympathetically mediated increases in peripheral resistance and cardiac activity. More blood loss, with further decrease in cardiac output, can result in withdrawal of these sympathetic compensatory mechanisms. Although only small volumes of blood are removed during blood donation, adverse reactions such as syncope and transient unconsciousness are known to occur. Occurrence of adverse reactions is a deterrent in blood donation behavior among donors. Objectives of the study were to measure the magnitude of hemodynamic responses in blood donation and identify donor characteristics which most affected them. Blood donors (n=103) were categorized into different groups based on age and times of previous donations. Baseline hemodynamic parameters–heart rate, systolic blood pressure, and diastolic blood pressure–were compared with same measurements during, immediately after, 5 minutes after, and 10 minutes after blood donation using Student's paired T test. Heart rate was mostly unchanged while there were significant falls in systolic and diastolic blood pressures after 5 and 10 minutes. Most significant reductions in blood pressures were observed in new donors and young donors. Clinically manifest adverse reactions occurred in 2% of donations. Young and first-time donors should be monitored more carefully during blood donation because these donors have less adequate hemodynamic compensatory responses to the acute blood loss.

Keywords: *blood donation, hemodynamic, novice donors, syncope, young donors.*

INTRODUCTION

Hemorrhage is a leading cause of death in both civilian and battlefield trauma. Hemorrhage may be classified as mild (400 to 550 ml blood loss, approximately 10% of total blood volume), moderate (550–1000 ml, 10–20% of total blood), and severe (more than 1000 ml, or more than 20% of total blood).[1] In conscious mammals including humans, the neurohumoral and hemodynamic responses to progressive hypovolemia have two distinct phases.[2] There is an initial arterial baroreceptor-mediated phase during mild to moderate hemorrhage. The fall in cardiac output is nearly matched by a sympathetically mediated increase in peripheral resistance so that arterial pressure is maintained near normal levels. When blood volume has fallen by a critical amount (approximately 30%), a second phase develops abruptly. This phase is characterized by withdrawal of sympathetic vasoconstrictive drive, relative or absolute bradycardia, an increase in release of adrenal catecholamines and vasopressin, and a profound fall in arterial pressure. The cardiac output then becomes inadequate and features of inadequate tissue perfusion manifest such as syncope, hypovolemic shock, unconsciousness, and death eventually.

Responses to acute blood loss can be studied by various experimental models.[1,3-5] Calculated volume of blood is withdrawn from an anesthetized or conscious animal such as pig, dog, rabbit, or monkey to observe the responses. Humans respond much similarly. Simulations of hypovolemic states in humans are created by head-up-tilt and lower body negative pressure procedures. Finally, hemodynamic monitoring and measurements are done on victims of traumatic incidents and blood donation camps.

Blood donation is the voluntary removal of whole blood from a healthy adult for the purpose of administering to a needy person. Thus, blood donation provides a unique opportunity to study the physiologic response of a healthy adult to acute blood loss. A usual procedure of blood donation removes about 200-550 ml of whole blood, depending on the national guidelines and need.[6]

This usually represents about 10% or less of the total blood volume. The removal of only small percentage of total blood volume is well-compensated in most cases. However, studies report that removal of 480 ml of whole blood causes slight decreases in systolic blood pressure (average 5mmHg fall) and a transient rise in heart rate in normotensive as well as

low-hypertensive subjects.[7] As a result, systemic syncopal type complications related to decreased cerebral perfusion are well-recognized and fairly common.[8] As many as 4% of all donors experience loss of consciousness during donations. Milder vasovagal reactions such as faintness, lightheadedness, and dizziness, are significantly more common. In a large scale study (n=145,678) in USA by Eder et al, incidence of systemic (syncopal-type) complications related to blood donation are associated more with the younger donors.[9] Presyncope occurrence was 8.9% in 16 to 17 years age group, 6.8% in 18 to 19 years group, and only 1.98% in 20 years or more age group. More severe systemic complications (syncope and loss of consciousness) occurred in 0.5%, 0.3%, and 0.08% instances respectively in the above age group donors.

Incidences of adverse reactions have significant effects on the return behavior of the donors. Eder et al, in the same study, observed that 73% of young first time donors who did not suffer adverse reactions returned for a second blood donation within the same year. In contrast, only 52% of novice donors who suffered minor adverse reactions (presyncope and syncope) returned for a second blood donation. When major adverse reactions occurred (transient loss of consciousness, with or without injury), the return rate decreased to only 31%.

In this study, we measured the extent of hemodynamic changes in response to blood donation in different subgroups of Nepalese donors, with view of verifying whether young and novice Nepalese donors respond in a similar manner. This could help identify donors more susceptible to developing systemic adverse reactions. Blood donation behavior could be reinforced as a result of decreasing incidence of adverse reactions by directing efforts to such donors during blood camps.

MATERIALS AND METHODS

Donors at the Blood Transfusion Service Center of the Nepal Red Cross Society, Kathmandu were recruited for the study. Participants were chosen by purposive, non-probability sampling method. Criteria for inclusion were donors of either sex, age 18-60 years, weight more than 45Kg, blood pressure 100/70-160/95 mmHg, last blood donation more than 3 months, and last menstrual period more than 8 days. Female participants during menstrual period and up to 8 days of last menstrual period, pregnant, lactating mothers; donors with systemic illnesses and/or receiving treatment; intake of any kind of drugs on the day of donation were excluded.

The study was conducted during the month of April, 2009. Relevant history and anthropometric data were obtained. Baseline heart rate in beats per minute (HR, bpm) and blood pressures (BP, in mmHg, measured using aneroid sphygmomanometer) were recorded in supine position, after resting the donor for at least 10 minutes, when the parameters had stabilized. Blood withdrawal was then started in the same position; about 350 ml blood was removed in 5-7 minutes. HR and BP were measured midway during the blood removal, immediately after completing blood removal, 5 minutes after, and 10 minutes after.

While the procedure involves removal of significant amount of blood by venepuncture, blood donation is obviously a noble voluntary act. The study did not require additional invasive procedures. Informed consent was obtained from the participants. The study was approved by the National Academy of Medical Sciences Ethical Committee.

Donors were categorized twice by age and by the number of previous blood donations (Table 1). Comparisons of donor groups were done by Student's paired t-test using the SPSS statistical tool. Level of significance was set at 95%. In the results presented, a p value less than 0.05 is denoted as *, less than 0.01 as **.

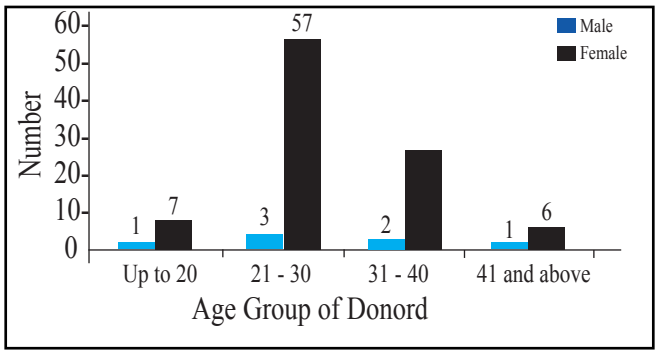
Table 1: Classification of donors by age and number of past donationsweeks intervention

Number of Past Donations	Total				Total
	Up to 20	21-30	31-40	41 & above	
First time	4	19	7	1	31
2 – 5	3	33	8	3	47
6 - 9	1	8	5	2	16
More than 9	0	0	8	1	9
Total	8	60	28	7	103

RESULTS

Total 103 volunteer donors, 7 females and 96 males, anticipated. Their average age was 29.1 years (±7.5, range 18-55), average height was 168.5 cm (±6.8, range 142-183), and average weight was 68Kg (±10.1, range 47-95). Most donors were aged 21–30 years (number 60); sex istribution among various age groups was comparable (fig 1). Average frequency of previous donations was 4.1 times (±4, range 1-21). Commonest ABO type was B (46 donors) followed by group O (n=29), A (n=21), and AB (n=7); two donors were Rhesus negative.

Figure 1: Sex distribution among different donor age groups



At baseline, the average HR was 84.48 bpm (±10.28). There was only a small change in overall HR response to blood donation. The maximum change in HR was a drop by 0.51% of the baseline at five minute (p value>0.5). Ten minute HR was less than baseline by 0.27%.

Average systolic blood pressure (SBP) was 126 mmHg

(±10.1), average diastolic blood pressure (DBP) 78.3 mmHg (±7.2), and average mean arterial pressure 94.2 mmHg (±7.3). There were decreases in both systolic and diastolic pressures in each subsequent measurement. BP changes midway during the blood donation were minimal but of significant magnitude

then after. Average systolic BP at ten minute (118.35 mmHg) was less than baseline by 6.1%; average diastolic BP at ten minute (75.05 mmHg) was less than baseline by 4.2%.

Donors were classified on the basis of age and number of previous blood donations (Table 1). The subgroups were compared to measure the influence of these factors on the physiological responses.

A. Hemodynamic responses in donors of different age groups (Table 2):

1. HR Responses: Average baseline HR was higher in the younger donors. HR of this group sharply decreased at midway during blood donation procedure (by 10.27% of baseline) and remained low throughout. Ten minute HR was less by 14.82% of the baseline. Donors in the second and third groups had stable HR throughout. However, HR changes were not significant statistically in any of the groups at any time.

2. SBP Responses: Average baseline SBP was similar among different age groups, with relatively higher blood pressure in the younger donors. Apart from a transient rise during the blood removal in some donors, there was sustained fall in SBP in most donors. The fall in SBP was most profound in the 21-30 years age group; SBP at ten minutes was less by 7.38% of baseline.

3. DBP Responses: Average baseline DBP was higher in the older donors. While DBP mostly decreased after blood donation, the fall was significant only in the 21-30 years age group, with ten minute DBP less by 6.15% of the baseline.

Table 2: Changes in hemodynamic parameters in donors of different age groups

Hemodynamic parameters		Measurements by Age Group			
		Up to 20	21 - 30	31 - 40	41 and above
HR (bpm)	Baseline	98.63	83.57	83.29	80.86
	During donation	88.5	83.77	84.5	82.57
	Immediately after	88.75	83.47	84.36	86.29
	After 5 min	87.5	83.23	84.82	84
	After 10 min	84.75	83.9	85	83.71
SBP (mmHg)	Baseline	130	124.33	128.39	126.43
	During donation	133.13	123.08	127.68	127.86
	Immediately after	125.63	118.08**	123.57**	120.71
	After 5 min	125	116.5**	121.61**	122.14
	After 10 min	125	115.25**	122.32**	121.43
DBP (mmHg)	Baseline	76.25	77.25	80.71	80.71
	During donation	75.63	76.92	80.36	84.29
	Immediately after	74.38	75.17*	79.96	81.43
	After 5 min	75.0	73.67**	79.11	80.71
	After 10 min	75.0	72.50**	79.29	80.0

B. Hemodynamic responses in relation to previous blood donation experiences (Table 3):

There was a positive correlation between donors' age and times of blood donation (significant correlation, $p = 0.01$). Younger donors had essentially donated blood fewer times than older donors. Most of the first time donors (19 out of 31, or 61.3%) were in the age group 21-30 years.

1. HR Responses: First-time (novice) donors had a higher baseline HR that showed a continuous fall pattern in subsequent measurements. In other groups, HR increased in most instances. However, none of the HR changes were of statistically significant magnitude.

2. SBP Responses: Average baseline SBP of different groups were comparable, and showed a falling pattern in serial measurements

in all donors. The most significant decreases were observed in the first time donors and donors with 2-5 past experiences. SBP change was least significant in the third group which comprised of experienced donors. Decreases in SBP were also significant in donors of the last group (more than 9 past donations) who also started with a higher baseline SBP.

3. DBP Responses: There was continuous fall in DBP in all groups. The fall was most profound and statistically significant only in the first time donors. In the second group, the decreases in DBP were significant at five and ten minutes after donation.

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Table 3: Changes in hemodynamic parameters in donor groups by frequency of past donations

Hemodynamic parameters		Measurements by frequency of blood donation			
		First time	2 to 5 times	6 to 9 times	More than 9
HR (bpm)	Baseline	88.6	82.89	84.38	84.89
	During donation	86.52	82.94	83.0	85.56
	Immediately after	85.42	82.68	85.88	86.29
	After 5 min	85.35	82.55	84.38	86.78
	After 10 min	85.16	82.85	84.5	88.0
SBP (mmHg)	Baseline	126.77	125.53	123.13	131.11
	During donation	126.61	125.0	125.31	123.89**
	Immediately after	121.45**	119.15**	121.56	120.56**
	After 5 min	118.55**	118.72**	119.38*	120.56*
	After 10 min	118.39**	117.13**	120.0	121.67**
DBP (mmHg)	Baseline	79.19	77.77	76.88	81.11
	During donation	77.26*	78.4	78.44	80.56
	Immediately after	76.29**	76.49	76.81	80.56
	After 5 min	75.81**	75.32*	74.69	79.44
	After 10 min	74.19**	74.47**	75.63	80.0

C. Adverse Effects:

Two donors had clinical features of volume insufficiency (dizziness, cold sweating, syncope) during the observed period of blood donation. The donors belonged to 21-30 years age group and 2-5 times past donations group.

DISCUSSION

While blood transfusion is an important measure to treat various conditions such as hemorrhage and anemia, blood donation itself is a health-threat due to acute blood loss. Studies have shown that even the limited volume of blood removal in a blood donation leads to definite fall in systolic blood pressure and increase in heart rate in donors.[7] As a result, adverse reactions inherent to acute blood

loss, such as presyncope and syncope, are fairly common among donors.[9] Studies have shown a higher incidence of adverse reactions in the young donors such as 16 and 17 years olds.[9] In Nepal, blood donation is recommended for healthy people of 18 years and above.[6,10]

An effort to associate donor characteristics with incidence of adverse effects is, to our knowledge, lacking in Nepal. The two events of adverse reactions in this study occurred in the donors of 21-30 years with 2-5 times past experiences. Falls by significant measure in SBP and DBP, which herald the syncopal attacks, occurred in most donors. However, BP falls were more marked in novice donors.

It is known that the apprehension associated with blood donation increases the level of anxiety and stress in healthy donors, evidenced by raised levels of baseline HR and blood pressures.[11] The features were observed in the young and first time donors. The expected physiologic response to acute blood loss would be activation of the sympathetic stimulation causing increased HR, cardiac contractility, and peripheral resistance. Apparent absence of such compensatory responses in the donors suggests that those donors are in more risk of developing the hypovolemiarelated adverse effects.

Findings of this study show that physiologic responses to blood donation are least adequate in novice and young donors. Thus, they are more prone to develop adverse reactions associated with the acute hypovolemia during blood donation, but larger studies are necessary for drawing robust conclusions. Young and first-time donors should be monitored more carefully during blood donation. This could help in decreasing the incidence of adverse reactions in blood donation camps and improve blood donation behavior among people. Studies involving longer duration of observation should be designed to determine the time by which physiologic hemodynamic parameters normalize after blood donation.

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