Evaluation of Approach of Fluid Resuscitation Protocols in Primary Trauma Care - A Survey-Based Experience

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ABSTRACT

BACKGROUND

Trauma is one of the leading causes of mortality worldwide. Haemorrhagic shock is a major factor leading to preventable trauma deaths, and optimum management of this condition significantly affects outcome. Fluid resuscitation measures in trauma have been a topic of debate since decades and guidelines regarding this have been continuously evolving. We conducted this study to evaluate common practices and management strategies being adopted among different specialties involved in trauma care.

METHODS

We used a web-based study tool and peer reviewed questionnaire was designed regarding basic aspects of fluid resuscitation in trauma patients. Survey was conducted amongst Indian doctors from various specialties involved in primary care of trauma, and they completed the self-administered e-survey.

RESULTS

The responses of 1000 participants fulfilling the inclusion criteria were considered for our observations. The results were analysed based on two major groups, the medical specialty group (anaesthetists, critical care physicians, emergency physicians) and the surgical specialty group (general surgeons, trauma surgeons and orthopaedic surgeons). There was a varied response among the two groups to every question in the survey.

CONCLUSIONS

Trauma deaths due to haemorrhagic shock could be mitigated if the right fluid in optimal amount is used at the correct time. We found that the initial impromptu response of the entire group of doctors was less than ideal in many of the basic fluid resuscitation approaches in the respondent groups. It was also noted that there were significant differences in opinion among the medical specialties and surgical specialties concerning the various aspects of fluid management in trauma.

KEYWORDS

Haemorrhagic Shock, Fluid Resuscitation, Survey, Trauma, Medical and Surgical Specialties

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BACKGROUND

Trauma is the leading cause of death worldwide observed in the individuals younger than 65 years.[1] India has very high proportions of trauma related causalities in the younger population especially due to road accidents. It continues to be responsible for more loss of life than cancer and heart disease puttogether.[2] Among various causes of trauma, road traffic accidents form the bulk.[3] India stands fourth in the rates of road traffic accidents.[4] The mortality rates reported among severely injured patients are up to 45 %.[5] It has been reported that ninety percent of trauma mortality occurring worldwide is seen in low and middle-income countries (LMICs).[6] In high income countries (HICs), mortality following trauma has significantly decreased, in comparison to LMICs, due to quick response and utilisation of golden hour effectively.[7] In our country, despite major advances in health infrastructure, trauma mortality has remained almost unchanged in the past few years.[8] The development of health infrastructures has been offset by many fold increase in chaotic road traffic density.

Haemorrhage has been found to be major factor contributing to mortality after injury and is the most common cause of preventable trauma deaths.[9] In contrast to other causes including traumatic brain injury (TBI), multi organ dysfunction syndrome (MODS), and sepsis-haemorrhagic shock occurs over a limited time frame with the usual time to death of being 2 - 3 hours after presentation.[10] Timely correction of altered physiology following haemorrhagic shock has a significant positive impact on patient outcome. The fluid resuscitation is considered almost as important as surgical treatment of the injured organs and tissues and it is very vital for restoring normalcy.[11]

The usual volume expanding non-oxygen-carrying fluids (e.g., crystalloid or colloid solutions) have been used extensively to restore intravascular volume in the cases with mild to moderate haemorrhage. However, in severe haemorrhagic shock, blood products form the main stay of treatment along with fluids.[10] Primary resuscitation of a trauma patient in haemorrhagic shock is the responsibility of medical specialties like emergency physicians, critical care physicians and anaesthesiologists and surgical specialties like general surgeons, trauma surgeons and orthopaedic surgeons. Doctors in these specialties are usually confronted with the multiplicity of complex situations where life-threatening haemorrhage has to be managed along with the interventions which have direct impact on trauma. The main focus of doctors involved in trauma care in a patient with haemorrhagic shock includes three factors-right choice of fluid, right quantity of fluid and at the right time. The clinical status of the patient dictates the amount and type of fluid or blood component to be transfused.[12] Restoring intravascular volume and oxygen-carrying capacity of blood is the primary objective of fluid management in trauma with primary goal of saving precious life. Most of the management strategies have evolved based on the experiences of various centres in managing the trauma. The expertise gained has been shared and its salient features have formed the corner stone of management. American College of Surgeons Committee on Trauma have developed a standard operating procedure (SOP) based on study of over two decades. Their recommendations are included in the advanced trauma life support (ATLS) course. This course has been designed and discriminated all over the world by the American College of Surgeons Committee on Trauma. More than 10 lakh health care providers in more than 80 countries have already been trained. ATLS has become the foundation stone of trauma care in recent years which provides a common algorithm and approach for practices in traumacare.[13]

Various specialties are involved in primary care of trauma patients, and despite presence of standard algorithms there are differences in decision making and treatment. This study was based on a questionnaire developed by the authors keeping in mind the fluid resuscitation protocols advised in ATLS protocol. We intended to find the awareness and choices made, regarding fluid resuscitation protocols among primary care givers of various medical and surgical specialties involved in trauma care. We also focused on the adequacy of fluid and blood product requirements in trauma patients and special situations like massive transfusion. This study was undertaken to observe the discrepancies among primary trauma care providers regarding fluid management in trauma despite ATLS algorithm. Moreover, it was noted that there is not much published literature available on the subject which elaborates the status of current practices.

METHODS

This was a descriptive questionnaire-based study conducted in 1100 bedded tertiary care teaching hospital in North India during February 2020.

Study tool development and identification of participants: The authors designed 12 single best answer questions to ascertain the fluid resuscitation protocols in trauma patients and did comparative analysis of practices in correlation with globally pronounced ATLS protocols. All questions were based only on key points in fluid management as per recent ATLS protocols. It was a pretested questionnaire. The proforma was tested for reproducibility by test-retest. Reliability of the questionnaire was assessed by using test-retest and the values of measured Kappa (k) = 0.82, weighted Kappa (kw) = 0.8. internal consistency of questionnaires was assessed by applying Cronbach's-Alpha ($\alpha = 0.72$). The target population of our study was doctors involved in primary management of trauma patients including anaesthetists, emergency physicians, critical care physicians, general surgeons, trauma surgeons and orthopaedic surgeons. We divided these specialties into two major groups, medical specialties (anaesthetists, critical care physicians, emergency physicians) and surgical specialties (general surgeons, trauma surgeons and orthopaedic surgeons). The questionnaire designed was peer reviewed to obtain the objective response and accordingly modified to get unbiased views. We also conducted a pilot study in our institute comprising 25 participants to check the clarity of our questions and feasibility of our survey. Following this we forwarded the link of questionnaire to the intended study population. The web-link was sent using email and common

social media platform, WhatsApp on an individualised basis. Participants were identified through their respective professional societies. The survey presented the case of a trauma patient with haemorrhagic shock arriving in the emergency department. The patient in-question was a 44 - year-old male, sustaining injury following road traffic accident without thoracic injury. Patient had no co-morbid illness. Patient was anxious and confused with a heart rate of 125 / min, respiratory rate of 32 / min and BP of 90 / 40 mm of Hg. Patient had oxygen saturation of 90 % on room air. The initial couple of questions were focused on primary specialty of the participants and involvement in primary care of trauma patients. Eventual questions were based on type of fluid, amount of fluid and special protocols in fluid and blood products administration in primary management of hypovolemic shock.

Data Collection and Analysis

We designed the questions using a popular free website, SurveyPlanet.com. After ensuring anonymity all intended participants were asked to complete the questionnaire. All responses which took more than 5 min to complete the survey and those who were not involved in primary management of trauma were excluded from our study. We took into account the initial 1000 responses that fulfilled the inclusion criteria, for the purpose of our study.

Statistical Analysis

All raw data was entered into Excel sheets and tabulated. Statistical analysis of the data was done using SPSS version 21. All data are presented with numbers and proportions for dichotomous and categorical variables, and with means and standard deviations (SDs) or medians and IQRs for continuous variables, as appropriate.

RESULTS

A total of 1000 participants fulfilling the inclusion criteria responded to the survey. 59 participants (apart from the 1000 survey participants) who answered that they were not involved in primary care of trauma patients were removed from the survey as per exclusion criteria. Among the total number of participants 20.5 % (N = 205) were orthopaedic surgeons, 31.8 % (N = 318) were general surgeons, 16.2 % (N = 162) were anaesthetists, 23.8 % (N = 238) were emergency physicians, 7 % (N = 70) were critical care physicians and 0.7 % (N = 7) were trauma surgeons (Figure 1). Here we also divided the participants into two groups. Surgeon group comprising general surgeons, trauma surgeons and orthopaedic surgeons with 53 % of participants (N = 530) and physician group comprising anaesthetists, critical care physicians and emergency physicians with 47 % (N = 470) participants. In the medical specialty group 83.8 % (N = 394) and 16.2 % (N = 76) included fluid resuscitation under primary survey and secondary survey respectively while in the surgical specialty group 82.5 % (N = 437) and 17.5 % (N = 93) included it under primary and secondary survey (Table 1).

In response to question regarding the amount of fluid bolus administration in our hypothetical patient, 61.8 % (N = 618) answered as 1 litre and 38.2 % (N = 382) answered as 2 litres. Among medical group 336 participants were in favour of 1 litre fluid bolus and in the surgical group 282 participants were in favour of the same (Table 1). In response to the question regarding type of fluid during initial phase of resuscitation in our hypothetical patient, 60.5 % (N = 605) participants preferred crystalloids, 29.8 % (N = 298) participants preferred colloids and 9.7 % (N = 97) preferred blood products. Among the participants who answered as crystalloids 376 belonged to surgical specialties and 229 belonged to medical specialties (Table 1). In response to, choice of fluid in our hypothetical patient if he had low Glasgow Coma Scale (GCS), 46.7 % (N = 467) responded as normal saline and 53.3 % (N = 533) responded as Ringers lactate.301 participants in the surgical group opted for normal saline while 165 in the medical specialty group did so. Similarly, 229 in the surgical specialty group and 305 in the medical specialty group opted for Ringers lactate (Table 1). In our question regarding need for blood products arrangement in our hypothetical patient, 66.4 % (N = 664) participants wanted to arrange blood while 33.6 % (N = 336) did not feel the need for blood arrangement. 54.8 % (N = 548) participants wanted to arrange individual blood components while 45.2 % (N = 452) wanted to arrange all three blood components.

Among participants who planned to arrange all three blood components 267 and 185 belonged to surgical and medical specialty group respectively (Table 1). In response to the question regarding exact protocol of blood transfusion only 21.3 % (N = 213) answered as packed red blood cells (RBC), fresh frozen plasma (FFP) and platelets in a 1:1:1 ratio at 10 - 20 ml / kg which is the recommended approach. In answer to our question regarding parameters to assess adequacy of fluid resuscitation 82.5 % (N = 825) wanted to use only clinical parameters and 17.5 % (N = 175) wanted to use both clinical and laboratory parameters (Table 1). Our next question was regarding further procedure in case our hypothetical patient did not respond to conventional fluid resuscitation measures. In response to this 69.6 % (N = 696) respondents wanted to continue fluid management with use of vasopressors and 30.4 % (N = 304) wanted to plan surgical / embolisation techniques for control of bleeding. Among respondents who wanted to proceed with surgical / embolisation measures, 206 belonged to surgical specialty group while 98 belonged to medical specialty (Table 1). Finally, in our last question regarding if the participants were aware regarding massive transfusion protocol, 49.7 % (N = 497) answered yes and 50.3 % (N = 503) answered no. Among participants who answered yes and were aware of the protocol 22.7 % (N = 113) were orthopaedic surgeons, 19.9 % (N = 99) were surgeons, 1.4 % (N = 7) were trauma surgeons, 7.4 % (N = 37) were critical care physicians, 24.3 % (N = 121) were emergency physicians and 24.1 % (N = 120) were anaesthetists. 219 participants in the surgical group and 278 among the medical specialty group were aware regarding this protocol. The rest were not aware (Table 1).

		Surgical N (%)	Medical N (%)	X^2 –Value	P-Value
Response regarding primary and secondary survey	Primary survey	437 (82.5 %)	394 (83.8 %)	0.34	0.56
	Secondary survey	93 (9.8 %)	76 (8.07 %)		
Response regarding quantity of fluid bolus		**Surgical**	**Medical**		
	1 litre	282 (28.2 %)	336 (33.6 %)	35.27	< 0.00001*
	2 litres	248 (24.8 %)	134 (13.4 %)		
Response regarding choice of initial resuscitation fluid		**Surgical**	**Medical**		
	Colloids	112 (11.2 %)	186 (18.6 %)	52.42	< 0.00001*
	Crystalloids	376 (37.6 %)	229 (22.9 %)		
	Blood products	42 (4.2 %)	55 (5.5 %)		
Response regarding initial fluid of choice in head injury		**Surgical**	**Medical**		
	Normal saline	301 (30.1 %)	165 (16.5 %)	47.07	< 0.00001*
	Ringer's lactate	229 (22.9 %)	305 (30.5 %)		
Response regarding necessity of blood product arrangement		**Surgical**	**Medical**		
	Required	360 (36 %)	304 (30.4 %)	1.17	0.278
	Not required	170 (17 %)	166 (16.6 %)		
Response regarding type of blood product arrangement		**Surgical**	**Medical**		
	Individual blood components	263 (26.3 %)	285 (28.5 %)	12.20	0.00047*
	Prbc + ffp + platelet	267 (26.7 %)	185 (18.5 %)		
Response regarding adequacy of fluid resuscitation		**Surgical**	**Medical**		
	Clinical parameters only	491 (49.1 %)	334 (33.4 %)	80.33	< 0.00001*
	Clinical + lab parameters	39 (3.9 %)	136 (13.6 %)		
Response regarding further approach in non-responders		**Surgical**	**Medical**		
	More fluid + vasopressor	324 (32.4 %)	372 (37.2 %)	38.21	< 0.00001*
	Surgical / embolisation	206 (20.6 %)	98 (9.8 %)		
Response regarding awareness of massive transfusion protocol		**Surgical**	**Medical**		
	Aware	219 (21.9 %)	278 (27.8 %)	31.67	< 0.00001*
	Not aware	311 (31.1 %)	192 (19.2 %)		

Table 1. Responses of Survey Questionnaire

*indicates statistically significant

Questionnaire

Questions	Single Best Answer Options
Are you involved in initial care and management of trauma patients	• Yes • No
What is your primary specialty?	• Trauma surgeon • Emergency physician • Anaesthetist • Orthopaedic surgeon • Critical care physician • General surgeon
Fluid resuscitation of trauma patients is included under?	• Primary survey • Secondary survey
How much fluid bolus will you advise in the hypothetical scenario?	• 1 litre • 2 litres
What will be your choice of fluid as initial bolus in the hypothetical scenario?	• Colloids • Crystalloids • Blood products
If the patient in the scenario has a head injury with low GCS what will be your crystalloid of choice?	• Normal saline • Ringers lactate
Will you ask for arrangement of blood products in this patient?	• Yes • No
What blood products will you arrange for the patient in this scenario?	• Packed RBC • Fresh frozen plasma • Platelet concentrate • All the above
What will be your protocol of blood transfusion in this patient?	• 10 – 20 ml / kg of RBC / FFP / PLT in 1:1:1 ratio • 30 – 40 ml / kg of RBC / FFP / PLT in 1:2:1 ratio • 10 – 20 ml / kg of RBC / FFP / PLT in 1:1:2 ratio • 10 – 20 ml / kg of RBC / FFP / PLT in 2:1:1 ratio
How will you assess the adequacy of fluid resuscitation in the previous scenario?	• BP monitoring • Urine output monitoring • BP + urine output monitoring • BP + urine output monitoring + ABG analysis
How will you proceed if this patient does not respond to fluid resuscitation measures including crystalloids and blood products?	• Continue fluid resuscitation with use of vasopressors • Plan surgical / embolisation control of blood loss
Are you aware of massive transfusion protocol?	• Yes • No

Table 2.

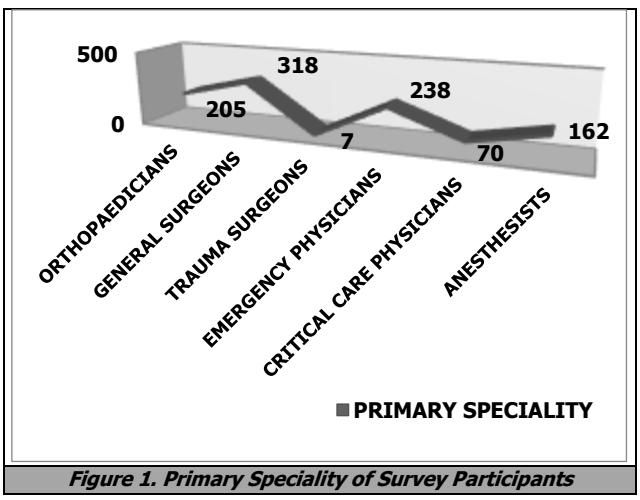

Figure 1. Primary Speciality of Survey Participants

DISCUSSION

The questionnaire was designed after peer review to ascertain the practical application of fluid resuscitation protocols. The distinctions were possible between involved health care provider in initial trauma care and participants who had the theoretical knowledge but were not engaged in a practical use. The response of such non practicing participants was excluded from the survey data from analysis. The participants who completed the questionnaire but were not practically involved in primary trauma and critical care were categories as general physicians. This perhaps shows a trend of critical care physicians in our country attending to patients inside the ICU after the initial resuscitative measures have been completed. This is contrary to the evaluation published by Weingart et al. who summarised the projected need for emergency department (ED)-intensivists for the best possible patient care.[14]

We recorded the primary specialty of participants and found that trauma surgeons who responded to our survey were very few. This can be explained by the fact that trauma surgery is a relatively new branch in our country with only one institute offering the dedicated super specialty course. This super specialised branch deals with comprehensive management of trauma including initial resuscitation, damage control surgeries and also trauma critical care.[15] It could thus, be inferred that countries with high trauma related mortality like ours should aim to train doctors at specialty and super specialist level in similar courses and number should be commensurate to the national needs.

Fluid resuscitation has formed an integral part of primary survey in trauma care. It is listed and considered most essential under the domain of circulation which is included under the basic airway, breathing, circulation, disability, exposure (ABCDE) approach in ATLS.[16] The findings of our study deduce that majority of the participants in both the surgical and medical specialty groups included it under primary survey and there was no statistically significant difference in opinion.

61.8 % of the participants revealed about the amount of fluid bolus used in resuscitation as one litre of bolus and 38.2 % said that they used two litres bolus. One striking feature noted in the survey was that medical specialty participants had an inclination for using 1 litre fluid bolus while surgical specialties were more in favour of two litres. This difference in use of amount of fluid bolus was found to be statistically significant in the practices. The recent ATLS guidelines recommend one litre of fluid bolus. The ATLS guidelines has been a matter of evaluation by many workers and Harada et al. have recently concluded in their research publication that low volume resuscitation was associated with significantly low mortality rates.[17] Excessive fluid administration can activate the lethal triad of hypothermia, coagulopathy and acidosis, as well as inflammatory cascade activation. Low volume resuscitation has been found to decrease intra-abdominal hypertension, compartment syndrome, tissue oedema, haemodilution, decreased platelet count and sepsis.[18,19] Hence, the strategy of permissive hypotension is being promoted in most recent fluid resuscitation studies.[17]

When we asked about the initial choice of fluid in our hypothetical patient, majority of the participants (60.5 %) were found to be using crystalloids which has been in conformity with current recommendation and as per recent ATLS guidelines. This view was supported by Ramesh et al. who concluded that crystalloids form the mainstay of initial resuscitation fluid in trauma patients.[19] Colloids were implicated in anaphylaxis, chances of renal injury and coagulopathy. This along with the cost effectiveness of treatment has reduced the preference of colloids as mainstay fluid in trauma.[19]

It was also noted that hypo-osmolar crystalloids (0.45 % saline, 5 % dextrose) have been traditionally avoided in head injury patients. Hypertonic saline and mannitol are the first line treatment of raised intracranial pressure but may not be initial choice in fluid resuscitation. However, choice of isotonic fluid in traumatic brain injury has always been a topic of intense discussions without much of clarity and remained inconclusive.[20] Commercially available fluids such as Ringers lactate is hypo-osmolar (273 mOsm / kg) and normal saline is iso-osmolar (308 mOsm / kg) these are the preferred fluid in traumatic brain injury.[21,22] Our participants were also divided in their opinion and faced confusion in this regard with 46.7 % responding as Ringers lactate and 53.3 % responding as normal saline as their choice in traumatic brain injury (TBI) patients. In our survey normal saline and Ringers lactate were the preferred fluid by both the surgeons and medical specialties in traumatic brain injury.

Two-third of the participants in our series wanted to arrange blood products while the rest did not hold this view. There was no significant difference in opinion regarding this among our two groups. Our hypothetical patient had a class – III haemorrhage as per his clinical parameters and required crystalloids and blood products as per recent ATLS guidelines. This is supported by Holcomb et al. who promoted the use of blood products early during resuscitation to decrease trauma related deaths in similar situations.[23] 45.2 % of the participants in the survey wanted to arrange all three blood components (PRBC, FFP, and platelet). Surgical specialty participants had more inclination for requisitioning individual components while medical specialties were more in favour of all three components. Blood component use in the correct proportion and dosage has been clearly defined in ATLS guidelines. Current data promote the use of packed RBC, FFP and platelet concentrate in 1:1:1 ratio at 10 – 20 ml / kg dosage. This decreases the incidence of coagulopathy and overall trauma related mortality rates.[12,23]

Majority of participants in our survey were in favour of using only clinical parameters in assessing the hydration status. The medical specialty group had slight varied opinion when considering clinical as well as laboratory parameters for this assessment. Assessment of adequacy of fluid resuscitation is very challenging clinically. Many methods have been traditionally defined but ATLS promotes use of BP monitoring, urine output monitoring and calculation of base deficit from arterial blood gas analysis as the standard technique. Serial measurements are more beneficial in seeing fluid responsiveness of the patient. This view is supported by Kalantari et al. who proposed vital signs, physical examination and laboratory parameters in assessment of volume status during fluid resuscitation.[24] There are multiple other techniques including central venous pressure, pulmonary capillary wedge pressure, passive leg raising, pulse pressure variation, stroke volume variation, inferior vena cava (IVC) diameter etc. which may help in assessing volume status.[24]

Many times, we come across scenarios where the trauma patient does not respond to conventional fluid resuscitation measures. In these situations, the clinician remains in dilemma regarding the next step of management. Our question regarding this scenario in our hypothetical patient revealed 69.6 % of our survey participants wanted to continue fluid resuscitation with additional use of vasopressors while 30.4 % wanted to plan surgical / embolisation techniques. Surgical specialty group had a strong disposition for planning early intervention while medical specialty wanted to continue conventional resuscitation with use of vasopressors. ATLS promotes the

use of surgical and embolisation techniques in minimal, slow responders or non-responders. This view is supported by the study of Rao et al.[25] and Rossaint et al.[26]

It was found that about 50 % of the study participants were aware regarding massive transfusion protocol in trauma patients. Participants in the medical group where significantly more aware than their surgical counterparts regarding this protocol. Massive transfusion is most commonly defined as greater than ten PRBC transfusions within 24 hours of admission. Initiation of massive transfusion protocol is based on Assessment of Blood Consumption score. It assigns one point each to, penetrating mechanism, heart rate (HR) > 90 bpm, positive focused assessment with sonography in trauma (FAST), or systolic blood pressure (SBP) < 90 mmHg. A score of greater than 2 is a trigger for starting massive transfusion protocol (MTP).[27]

CONCLUSIONS

Haemorrhagic shock is the most common and rapid cause of trauma related deaths and this can be managed very optimally by efficient fluid resuscitation measures. Few of the impromptu responses of participants regarding basic fluid management protocols in trauma were less than ideal with differences of opinion among various specialties. Similar studies done on a larger population can analyse the gap between standardized protocols (ATLS) and actual clinical practices being followed. We also recommend increased and periodic training of health care-workers involved in trauma care with regular updating as per recent guidelines. Similar surveys at regular intervals with increased trauma training as per recent guidelines will further improve our preparedness to handle trauma and decrease trauma related deaths. It is recommended that the study should be conducted on a larger sample with inclusion of all medical colleges, district hospitals, and polyclinics to ascertain the current status of fluid resuscitation protocols.

Strengths and Limitations of Our Study

- Our survey was conducted on application of basic fluid resuscitation practices in trauma and included a large sample of participants in various branches of medicine dealing primarily with trauma patients.
- The survey was crisp, short, simple, consuming less time and dealt exclusively with fluid resuscitation in the initial management of trauma.
- Survey was designed to be replied promptly in minimal time (say five minutes) only and each question could be answered only once. This survey design helped in minimising bias due to mutual discussions or answering after referring. This helped to get impromptu responses from the participants.

Since, the survey focused on the early fluid resuscitative measures in haemorrhagic shock in trauma, the responses to questions may not be generalisable to other types of shock encountered in trauma.

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