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**ORIGINAL ARTICLE**

# Controlled Blood Pressure Rise Through Limited Fluid Resuscitation in Treating Multiple Injuries in Permutation with Shock and its Impact on Post-Resuscitation Hemoglobin Level

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## ABSTRACT

**Background:** Trauma is the largest root of death because 30% of trauma-related casualties are attributable to hemorrhages. Concerns were heaved about aptness of traditional doctrine of vigorous crystalloid resuscitation in these cases.

**Objectives:** The study comparatively studied conventional and limited fluid resuscitation in control of blood pressure elevation and their effects on hemoglobin concentration.

**Methods:** This exploratory study was conducted in Ali Fatima Hospital/ Abu Umara Medical and Dental College, Raiwind Road Lahore, comprising 340 patients who presented to the Trauma Center, with intensified multiple organ injury or shock and then transferred to ICU. Patients were allocated into two groups viz experimental (n=170) and control (n=170) and were administered with intravenous fluids via conventional mode and experimentally through limited resuscitation.

**Results:** Recovery time of the experimental group (2.78+1.41) was significantly lesser ($p<0.05$) than control (3.41+1.78). Hemoglobin concentration was significantly improved ($p<0.05$) in the patients of experimental groups (mean 11.12+2.39 g/dl), then control. The incidence of mortality, shock, hypothermia and hemorrhages was significantly reduced ($p<0.05$) in experimental group, while hypoxia and intravascular coagulation were increased ($p>0.05$) in patients of the control groups.

**Practical implications:** The clinicians should shift to limited fluid resuscitation to minimize the complications in trauma patients.

**Conclusion:** The recovery rate and effective hemoglobin concentration were significantly improved in experimental patients, with reduced incidence of complications due to hemorrhages.

**Keywords:** Electrolytes; Hypothermia; Hypoxia; Multiple organ failure; Resuscitation.

## INTRODUCTION

Multi-trauma-induced shock is a common and serious medical emergency and traumatic injuries represent roughly 10% of the global illness burden. Active bleeding that is difficult to stop at the initial visit due to the severity of the underlying injury might generate multi-organ dysfunction and systemic inflammatory response syndrome, which can pose a grave threat to patients' lives [1]. It is the chief preventable root of fatality among wounded patients. Rehydrating trauma patients with fluids, reinstate their blood volume, restore tissues perfusion and decreases casualties [2-3]. Strategies for fluid delivery are based on volume, pace and duration. Historically, vigorous fluid resuscitation was customary process for restoring circulatory volume and maintaining trauma patients' tissue perfusion. Nevertheless, it extricated malleable clots and generated dilutional coagulopathy, ensuing increased bleeding and death [4-5]. Large crystalloid infusions given to trauma patients resulted in resuscitation injury, cardiac and gastrointestinal concerns, elevated pressures in extremities, coagulation disorders and electrolyte imbalance [2].

To evade clot distraction and dilutional coagulopathy, two techniques were prepared: delayed resuscitation, where fluids were governed after bleeding is restricted. Second: Permissive hypotension, in which fluids were administered to lift up SBP without attaining normotension. During permissive hypotension, low-amount fluid resuscitation sustained low tissue perfusion, yet is sufficient for brief periods. Permissive hypotension is achieved through goal-directed resuscitation or controlled resuscitation (predetermined fixed infusion rates are administered such that normotension is not attained) [6-7].

In controlled resuscitation, in the first two hours, it utilizes 1 Liter less fluid than normotensive resuscitation on average. Non-significant difference in laboratory values was observed, however, protocol for damage control resuscitation called for less crystalloid fluid and more blood products. It was hypothesized that rigorous fluid administration prior to surgical intercession and bleeding management would increase blood loss, dislodge clots and perhaps result in subsequent hemorrhage [8-9].

The study was done to analyze the controlled BP rise through limited fluid resuscitation in treating multiple injuries in combination with shock, to increase survival and promote recovery and its impact on post-resuscitation hemoglobin level.

## MATERIAL AND METHODS

**Study locale and period:** This exploratory study was conducted from July 2021 to January 2023, including 340 patients presented to the Ali Fatima Hospital/ Abu Umara Medical and Dental College, Raiwind Road Lahore, with stern septic shock due to multi-injuries, then transferred to ICU. Subjects were classified as:

1. Experimental group
2. Control group

Experimental group was administered with controlled BP elevation through limited fluid resuscitation, while control group patients were managed as per routine resuscitation policy.

**Eligibility criteria:** Patients presented at the Trauma Center, who were then shifted to ICU with rigorous multi-injury-induced shock, multiple injuries, systolic pressure below 60 mm of Hg and hypovolemic shock were included. While the patients, expired in ICU after admission within two days or with intense hypertension were excluded from study.

**Study design:** After the admittance of patients in ICU, they initially managed their injuries by dressing and antiseptic applications. The patients were given tracheal intubation or assisted mechanical ventilation based on clinical status. Then, their arterial blood pressure indices were evaluated. Other indicators like ECG, oxygen saturation, body temperature, etc were constantly monitored and two effective venous routes were constructed for fluid resuscitation.

The colloidal solutions, normal saline (7.5%) and plasma extenders were administered to the patients through intravenous routes to restore effective blood volume while continuously monitoring the vital signs. The active hemorrhages were surgically

managed under a strict aseptic approach. In control group, standard fluid resuscitation and controlled BP elevation were administered. The average arterial pressure was maintained between 60 and 100 mmHg to provide enough blood flow to vital organs.

After completing the fluid resuscitation, its impact was compared on pre and post-fluid administration on blood hemoglobin concentration.

**Statistical analysis:** Data pertaining to the demographics of study patients as well as traumatic injuries and pathological complications and outcomes were entered into an MS Excel spreadsheet and analyzed using SPSS version 24 for Windows. For qualitative data, findings were expressed as percentages and for quantitative data, as mean and standard deviation. The p-values of 0.05 after correction was assumed statistically significant and Chi-square test was the statistical tool for analysis of this data.

## RESULTS

This exploratory study was conducted in Ali Fatima Hospital/ Abu Umara Medical and Dental College, Raiwind Road Lahore comprising 340 patients who presented to the Trauma Center, and were then shifted to ICU, were categorized into two groups viz experimental (n=170) and control (n=170) group (Figure 1).

At the very outset, blood loss from the patients due to trauma and multiple injuries was estimated and it was found that patients in the experimental group showed blood loss <700ml (56.47%), 700-1500ml (30.58%) and more than 1500ml blood was lost from 12.94%. Similarly, <700ml blood was lost from 68.82% of patients, 700-1500ml from 22.35% and >1500ml from 8.82% of patients (Table 1). Patients in the ICU were administered normal saline (7.5%), plasma extender, and colloidal solutions for resuscitation. In experimental group, patients were administered limited fluid resuscitation with controlled BP increase upto 40-50 mm Hg, whereas in control, conventional uncontrolled fluid therapy was administered and the average arterial blood pressure was raised to 60 to 100 mm Hg (Table 2). It was found from Table 3 that mean recovery time of experimental group (2.78+1.41) was significantly lower ($p<0.05$) than control group treated with conventional fluid resuscitation (3.41+1.78). The hemoglobin concentration was determined at the time of admission in the ICU (pre-resuscitation) and after recovery of the patients (post-resuscitation) and the findings reported Hb concentration in experimental group was significantly improved ($p<0.05$) in the patients of experimental groups (mean 11.12+2.39 g/dl), than control group (Table 4). The association of complications in patients of both experimental and control groups was studied and comparatively analyzed. The results revealed that the incidence of mortality, shock, hypothermia and hemorrhages was significantly reduced ($p<0.05$) in experimental group than control, while hypoxia and intravascular coagulation were also increased ($p>0.05$) in the patients of control groups (Table 5).

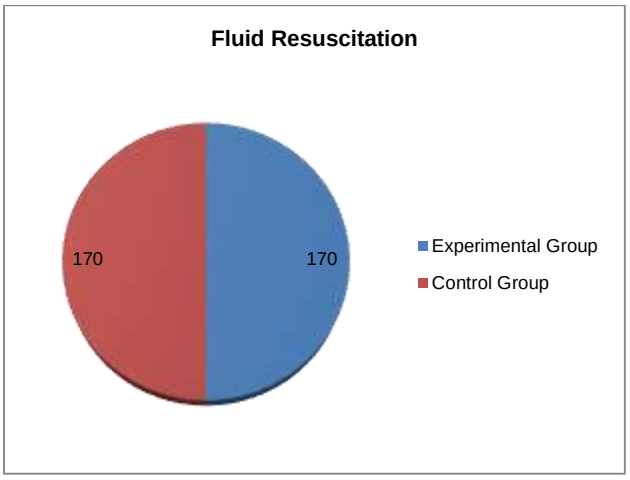


Figure 1: Allocation of patients into experimental and control groups

Table 1: Blood loss due to trauma and injuries in the patients of experimental and control groups

| Group | <700ml | 700-1500ml | >1500ml |
|---|---|---|---|
| Experimental n(%) | 96 (56.47) | 52 (30.58) | 22 (12.94) |
| Control n(%) | 117 (68.82) | 38 (22.35) | 15 (8.82) |

Table 2: Type and mode of fluid administration in the patients of experimental and control groups

| Group | Fluid type | Fluid resuscitation | Average Blood pressure maintenance (arterial) |
|---|---|---|---|
| Experimental | Normal saline (7.5%) Plasma Extenders Colloidal solutions | Limited | 40-50 mm of Hg |
| Control | | Conventional | 60-100mm of Hg |

Table 3: Recovery time estimation after fluid resuscitation

| Group | Range | Mean + SD | Median |
|---|---|---|---|
| Experimental (hours) | 1-4 hours | 2.78+1.41 | 2.54 |
| Control (hours) | 1-5 hours | 3.41+1.78 | 2.90 |

Table 4: Impact on hemoglobin concentration pre and post-fluid resuscitation

| Group | Range | | Mean + SD | | Median | |
|---|---|---|---|---|---|---|
| | Pre resuscitation | Post resuscitation | Pre resuscitation | Post resuscitation | Pre resuscitation | Post resuscitation |
| Experimental (g/dl) | 5-8 | 7-12 | 6.85+2.19 | 11.12+2.39 | 6.77 | 11.18 |
| Control (g/dl) | 5-8 | 6-10 | 6.98+2.33 | 10.01+2.14 | 6.81 | 10.80 |

Table 5: Association of complications in patients of both groups

| Complication | Experimental group | | Control group | | Chi-square | p-value |
|---|---|---|---|---|---|---|
| | No. of patients (n) | Frequency (%) | No. of patients (n) | Frequency (%) | | |
| Mortality | 7 | 4.11 | 29 | 17.05 | 11.00 | 0.0009* |
| Shock | 13 | 7.64 | 52 | 30.58 | 18.63 | 0.00001* |
| Hypothermia | 11 | 6.47 | 44 | 25.88 | 15.97 | 0.00006* |
| Hypoxia | 5 | 2.94 | 12 | 7.05 | 1.984 | 0.1589 |
| Intravascular coagulation | 2 | 1.17 | 3 | 1.76 | 0.0 | 0.9947 |
| Hemorrhages | 7 | 4.11 | 19 | 11.17 | 4.26 | 0.0388* |

*indicated that the value is significant at $p<0.05$

## DISCUSSION

Globally, trauma is the largest cause of death, and about 30% of trauma-related deaths are attributable to blood loss. Concerns were raised about appropriateness of traditional values of vigorous crystalloid resuscitation in traumatic hemorrhagic shock. Recent investigations have demonstrated that early volume restoration in certain types of trauma prior to definitive hemostasis can lead to increased blood loss, hypothermia and dilutional

coagulopathy [10-11]. Our findings were evident that recovery rate and effective hemoglobin concentration were significantly improved in experimental patients and also occurrence of complications was significantly lower ($p<0.05$) in patients managed with limited fluid resuscitation ($p<0.05$).

A study reported that for patients with shock, excessive fluid infusion in ICU would dilute blood and affect coagulation function; C-reactive protein and prothrombin time directly influence coagulation function and tissue contagion and patients' injury, which have important clinical and prognostic implications [12-13]. Such findings were consistent with our results. As information on fluid resuscitation evolved, it got prudent to utilize mostly balanced crystalloids for first fluid resuscitation of hypovolemic shock [14]. It was found that compared to saline, balanced crystalloids reduced mortality and renal dysfunction among individuals in ICU. Albumin amplified casualties in traumatic brain injury and had chief function in therapeutics of septic shock [15]. Selecting the amount of fluid to deliver during and after resuscitation for each patient needs a sophisticated weighing of benefits and dangers. Use mostly balanced crystalloids and exercised available hemodynamic monitoring to guide additional fluid delivery for majority of patients requiring fluid resuscitation in critical stage [16-17].

Despite their extensive use, numerous intravenous fluids have been introduced into clinical practice devoid of comprehensive study of their protection and effectiveness. Several of these fluids have been pulled from the market as a result of high-quality, investigator-initiated research demonstrating their unacceptable toxicity; however, others are still controversially in operating. The notion that dehydration and hypovolaemia exacerbate kidney and other essential organ damage, led to permissive approaches to fluid therapy and opinion that tissue edema are 'normal' during critical ailments; are harmful to patients [18-20].

## CONCLUSION

It was concluded that the recovery rate and effective hemoglobin concentration were significantly improved in experimental patients and also probability of complications was extensively lower in patients managed with limited fluid resuscitation than conventional fluid resuscitation. Moreover, controlled blood pressure elevation through limited fluid resuscitation is the best intravenous fluid administration strategy to prevent fatal complications in trauma patients and reduce the chances of hypothermia and cardiogenic shock.

**Conflict of Interest:** None.

## REFERENCES


1. Lu Y, Liu L, Wang J, Cui L. Controlled blood pressure elevation and limited fluid resuscitation in the treatment of multiple injuries in combination with shock. Pak J Med Sci. 2018;34(5):1120-1124.
2. Ramesh GH, Uma JC, Farhath S. Fluid resuscitation in trauma: what are the best strategies and fluids?. Int J Emerg Med. 2019;12:38.
3. Haagsma JA, Graetz N, Bolliger I, Naghavi M, Higashi H, Mullany EC, et al. The global burden of injury: incidence, mortality, disability-adjusted life years and time trends from the Global Burden of Disease study 2013. Inj Prev. 2016;22(1):3–18.
4. Cherkas D. Traumatic hemorrhagic shock: advances in fluid management. Emerg Med Pract. 2011;13(11):1–19.
5. Albreiki M, Voegeli D. Permissive hypotensive resuscitation in adult patients with traumatic haemorrhagic shock: A systematic review. Eur J Trauma Emerg Surg Off Publ Eur Trauma Soc. 2018;44(2):191–202
6. Murad MK, Larsen S, Husum H. Prehospital trauma care reduces mortality. Ten-year results from a time-cohort and trauma audit study in Iraq. Scand J Trauma Resusc Emerg Med. 2012;20:13.
7. Lewis SR, Pritchard MW, Evans DJ, Butler AR, Alderson P, Smith AF, et al. Colloids versus crystalloids for fluid resuscitation in critically ill people. Cochrane Database Syst Rev. 2018;8:000567.
8. Woodward K, Alsabri M. Permissive hypotension vs. conventional resuscitation in patients with trauma or hemorrhagic shock: A Review. Cureus. 2021;13(7):e16487.
9. Kolarik, Melissa MSN, Roberts ABC, Eric DNP, FNP-BC, ENP-BC. Permissive Hypotension and Trauma: Can Fluid Restriction Reduce the Incidence of ARDS?. J Trauma Nursing. 2017;24(1):19-24,
10. Chatrath V, Khetarpal R, Ahuja J. Fluid management in patients with trauma: Restrictive versus liberal approach. J Anaesthesiol Clin Pharmacol. 2015;31:308-16.
11. Morrison CA, Carrick MM, Norman MA, Scott BG, Welsh FJ, Tsai P, et al. Hypotensive resuscitation strategy reduces transfusion requirements and severe postoperative coagulopathy in trauma patients with hemorrhagic shock: Preliminary results of a randomized controlled trial. J Trauma. 2011;70:652-63.
12. Wang JW. Clinical significance of change of C-reactive protein of emergency patients with multiple injuries. Mod Diag Treat. 2012;23(8):1178-1179.
13. Li LZ, He SB. Limited fluids resuscitation (LFR) and damage control surgery (DCS) in the emergency treatment of severe multiple injuries with hemorrhagic shock. J Dalian Med Univ. 2016;38(4):344-347.
14. Casey JD, Brown RM, Semler MW. Resuscitation fluids Review. Current Opinion. 2018;24(6): 512-518.
15. Barjaktarevic I, Toppen WE, Hu S, et al. Ultrasound assessment of the change in carotid corrected flow time in fluid responsiveness in undifferentiated shock. Crit Care Med. 2018; 46(11):1040-1046.
16. Georges D, de Courson H, Lanchon R, et al. End-expiratory occlusion maneuver to predict fluid responsiveness in the intensive care unit: an echocardiographic study. Crit Care. 2018; 22:32.
17. Myatra SN, Prabu NR, Divatia JV, et al. The changes in pulse pressure variation or stroke volume variation after a 'Tidal Volume Challenge' reliably predict fluid responsiveness during low tidal volume ventilation. Crit Care Med. 2017;45:415–421.
18. Myles, P. S. et al. Restrictive versus liberal fluid therapy for major abdominal surgery. N. Engl. J Med. 2018;378:2263–2274.
19. Semler MW, Self WH, Wanderer JP, Ehrenfeld JM, Wang L, Byrene DW, et al. Balanced crystalloids versus saline in critically ill adults. N Engl J Med. 2018;378:829–839.
20. Myburgh, J. Patient-centered outcomes and resuscitation fluids. N Engl J Med. 2018;378:862–863.