



# Leukocyte Count as a Predictor of Severity of Injury in Pediatric Blunt Abdominal Trauma

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## Abstract

**Background and Aim:** Many pediatric trauma patients show increased leukocyte counts at presentation. These counts return to normal after resuscitation, but increase following re-bleeding or infection. This study analyzed the relationship between leukocytosis and the severity of injury in pediatric patients with blunt abdominal trauma.

**Methods:** Data were collected from patients aged 0 to 14 years admitted with blunt abdominal trauma from June 2009 to December 2014. The severity of injury was assessed using the Pediatric Trauma Score (PTS). PTS compared in patients with leukocyte counts  $\geq 11,000/\mu\text{l}$  and  $<11,000/\mu\text{l}$ .

**Results:** Ninety-seven patients were evaluated, 81 (83.5%) males and 16 (16.5%) females, of mean  $\pm$  SD age  $7.75 \pm 3.99$  years and mean initial White Blood Cell (WBC) count  $18,240 \pm 8,006/\mu\text{l}$ . Mean WBC was significantly higher in patients with PTS score  $<12$  than PTS score  $=12$  ( $20,160 \pm 8,870/\mu\text{l}$  vs.  $14,560 \pm 4,500/\mu\text{l}$ ;  $p < 0.0001$ ) and in patients with PTS score  $\leq 8$  than  $>8$  ( $21,500 \pm 9,016/\mu\text{l}$  vs.  $16,360 \pm 6,751/\mu\text{l}$ ;  $p < 0.002$ ). In patients with bleeding episodes, leukocytosis occurred before hemoglobin concentration was reduced.

**Conclusion:** Leukocytosis may be a predictor of occult injury but does not reflect the severity of injury in pediatric patients with blunt abdominal trauma. Leukocytosis may, however, be predictive of bleeding episodes during the course of patient management.

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**Keywords:** Blunt trauma; Abdomen; Leukocytosis

## Introduction

Identifying an intra abdominal injury before imaging may assist in early management. Leukocyte counts are routinely measured in all trauma patients as part of Complete Blood Cell (CBC) counts. Many pediatric trauma patients have increased leukocyte counts at presentation, which return to normal after resuscitation. Moreover, leukocyte counts have been reported to increase in patients with re-bleeding or infection. This study was designed to assess the relationship between leukocytosis and the severity of injury in pediatric patients with Blunt Abdominal Trauma (BAT). If leukocyte count was an indicator of severity of injury, it could be used to guide early management of patients with BAT.

## Materials and Methods

This study was performed at Hamad General Hospital, a level 1 trauma center and the only trauma center in Qatar for adults and children. Data collection started in June 2009 as a retrospective review. However, due to the absence of a significant number of files because many pediatric trauma patients are visitors, patients were enrolled prospectively from July 2010 to December 2014. The study included all patients aged 0 to 14 years with blunt abdominal trauma. Patients with penetrating injuries and compound fractures were excluded.

CBC was routinely measured in all trauma patients on admission and every 6 hrs thereafter until patient stabilization. The severity of injury was assessed using the PTS [1]. Parameters measured included age, sex, weight, type of injury, Hemoglobin (Hb) concentration, White Blood Cell (WBC) count, Glasgow Coma Scale (GCS) score, Pulse Rate (PR), Respiratory Rate (RR), radiology results and associated injuries (Table 1). WBC was considered high at  $\geq 11,000/\mu\text{l}$  [2]. The relationship

**Table 1:** Descriptive Statistics for Quantitative Variables.

Variable	Mean	Median	SD	Range
Weight	25.22	21	23.5	124
Age	7.75	8	4	13
WBC	18.24	17	8	44
PTS	8.81	11	3.76	11
RTS	11.13	13	3.42	12
ISS	18.59	16	12.2	57
GCS	12.96	15	4.42	12
Hb	11.5	12	1.81	8
LOS	9.9	6	13.76	111
ICU LOS	5.16	2	12.6	93
PR	76.6	87	57.72	198
DPB	61	66	25.2	122
SBP	88.27	116	51.7	155

WBCs: White Blood Cells; PTS: Pediatric Trauma Score; RTS: Revised Trauma Score; ISS: Injury Severity Score; GCS: Glasgow Coma score; Hb: Hemoglobin; LOC: Length of Hospital Stay; ICU LOC: Intensive Care Length of Stay; PR: Pulse Rate; DBP: Diastolic Blood Pressure; SBP: Systolic Blood Pressure

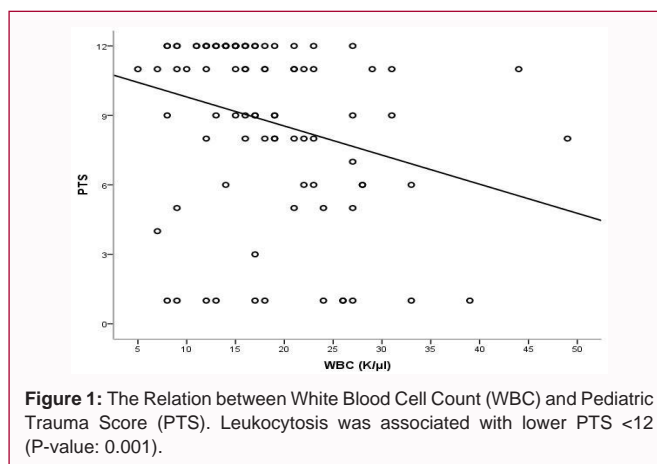
between WBC counts and PTS were assessed using PTS cutoffs of 12 and 8. Results were compared statistically using t-tests.

## Results

The 97 pediatric BAT patients analyzed during the study period included 81 (83.5%) males and 16 (16.5%) females; of mean age  $7.75 \pm 3.99$  years and mean WBC count  $18,240 \pm 8,006/\mu\text{L}$ . WBC counts were analyzed in relation to PTS (Figure 1). Mean WBC counts were significantly higher in patients with PTS scores  $<12$  than  $\geq 12$  ( $20,160 \pm 8,870/\mu\text{L}$  vs.  $14,560 \pm 4,500/\mu\text{L}$ ;  $p < 0.001$ ) and in patients with PTS scores  $\leq 8$  than  $>8$  ( $21,500 \pm 9,016/\mu\text{L}$  vs.  $16,360 \pm 6,751/\mu\text{L}$ ;  $p < 0.002$ ). WBC counts increased significantly in patients who experienced re-bleeding during the course of treatment, with WBC counts increasing a few hours before the reduction in Hb. Of 13 patients who experienced reductions in Hb after being stabilized and received blood transfusion, 12 showed an increase in WBC counts in the CBC before the reduction in Hb, which usually occurred within 6 hours. Analyses showed that increased WBC counts were associated with higher lengths of ICU and hospital stay, Lower GCS, lower Hb concentration and higher death rate (Table 2).

## Discussion

WBC is an acute phase reactant that can increase after trauma due to the release of stress neurohormones [3]. Few studies have assessed the relationship between WBC counts and the severity of BAT in either children or adults, and several of these studies have yielded contradictory results. For example, a study of 805 patients aged  $<13$  years who experienced abdominal trauma from 2005 to 2008 found that 671 (83.4%) had minor and 134 (16.6%) had major injuries [2]. The mean WBC count was higher in the group with major injuries, but there was no firm cutoff value. A retrospective evaluation of 1040 children aged  $<15$  years with BAT treated at a single trauma center found that 559 (54%) were at high risk and 481 (46%) were at moderate risk for intra-abdominal injury, with the mean WBC count being higher in the group at moderate than at no risk for intra-abdominal injury [4]. A study of 156 patients with BAT found that elevated leukocyte counts were significantly associated with longer ICU stay ( $P < 0.006$ ) and higher ISS ( $P < 0.002$ ) [5]. A prospective study



**Figure 1:** The Relation between White Blood Cell Count (WBC) and Pediatric Trauma Score (PTS). Leukocytosis was associated with lower PTS  $<12$  (P-value: 0.001).

**Table 2:** Association of Leukocytosis with Other Variables.

Variable	WBCs $<11$ (Mean $\pm$ SD)	WBCs $\geq 11$ (Mean $\pm$ SD)	Significance
LOS	13 (5.31 $\pm$ 4.63)	76 (11 $\pm$ 14.8)	Longer LOS
ICU LOS	7 (2 $\pm$ 1)	50 (5.66 $\pm$ 13.55)	Longer ICU LOS
GCS	13 (13 $\pm$ 5)	77 (13.01 $\pm$ 4.3)	Same GCS
Hb	13 (11.7 $\pm$ 1.84)	76 (11.53 $\pm$ 1.83)	Lower Hb
Deaths	1	5	Higher Deaths

LOC: Length Of Hospital Stay; ICU LOC: Intensive Care Unit Length of Stay; GCS: Glasgow Coma score; Hb: Hemoglobin

of all trauma patients admitted to a level 1 trauma center for more than 24 hrs found that WBC counts were not predictive of the need for volume resuscitation, transfusion, or surgery [6]. A retrospective evaluation of 279 patients with BAT, 142 with and 137 without significant injury, found that a significant elevation in WBC, even in patients with minimal initial signs of severe injury, was indicative of occult injury [7]. Taken together, these findings indicated that WBC count alone was not a marker for or against serious injury in blunt trauma patients, with no linear relationship between WBC count and severity of injury in patients with BAT.

The present study found that mean WBC was significantly higher in patients with PTS scores  $<12$  than  $\geq 12$  ( $p < 0.001$ ), as well as in patients with PTS score  $\leq 8$  than  $>8$  ( $p < 0.002$ ), indicating that mean WBC was almost the same in patients with minor injury (PTS  $<12$ ) and major (PTS  $\leq 8$ ) injury. Mean WBC count was higher in patients who died, those with lower Hb, and patients with longer ICU and hospital stay. Thus, the occurrence of leukocytosis in patients with BAT is indicative of intra-abdominal injury, but WBC count was not linearly related to the severity of injury. More interestingly, we observed a secondary increase in WBC count in 12 of 13 patients (92.3%) who experienced a bleeding episode and received blood transfusions during the course of treatment. Moreover, leukocytosis occurred prior to the drop in Hb concentration. Additional studies in larger numbers of patients are required to confirm this result.

## Conclusion

Leukocytosis may predict an occult injury but not the severity of injury in patients with BAT. Leukocytosis may, however, predict bleeding episodes during the course of treatment.

## Authors' Contributions

AAI initiated the study, participated in data collection, performed statistical analyses and sequence alignment, and drafted

the manuscript. AMI initiated the idea of trauma research. MAA participated in the sequence alignment. FHI participated in data collection. AAS conceived of the study and participated in its coordination. All authors read and approved the final manuscript.

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