International Journal of Science Academic Research
Vol. 04, Issue 12, pp.6731-6734, December, 2023
Available online at http://www.scienceijsar.com

ISSN: 2582-6425

Research Article

ARE POINT OF CARE DEVICES EFFECTIVELY REPLACING CONVENTIONAL LABORATORY TESTING: CORRELATION OF COAGULATION PROFILE PERFORMED BY THE TWO METHODS IN ADULT TRAUMA PATIENTS IN INDIA

Dr. Jayaram S., Dr. Nisha Ravikumar, Dr. Arin Choudhury, *Dr. Santvana Kohli and Dr. Nikki Sabharwal

Department of Anaesthesia and Intensive Care, Vardhman Mahavir Medical College and Safdarjung Hospital, New Delhi, India

Received 27th October 2023; **Accepted** 24th November 2023; **Published online** 29th December 2023

Abstract

Background: Polytrauma patients frequently develop coagulopathy, which can have an adverse effect on patient outcome. Early diagnosis of coagulopathy is prudent for initiation of management, which is often not possible with central laboratory services. Point of care (POC) devices may prove useful in providing early and reliable coagulation parameters. **Material and methods:** Adult trauma patients, without any prior history of coagulation disorder or anticoagulant therapy, admitted to Emergency Department (ED) were recruited for the study. Blood samples were drawn from them before initiation of resuscitation, as well as after fluid resuscitation. The samples were sent to central laboratory as well as Point of Care (POC) device Abbott iSTAT™ available in our ED for coagulation profile. **Results:** In the study population of 50 patients the correlation between lab-INR & POC-INR measurements was found to be moderately positive (Pearson's coefficient, r = +0.66) and strongly positive (r = +0.762) after fluid resuscitation. The sensitivity, specificity, positive predictive value, and negative predictive values of the POC device were found to be 62.5%, 92.9%, 62.5%, and 92.9% respectively. The average time taken for laboratory and POC results were 3 ±1 hours & 4 ± 1 minutes respectively. **Conclusion:** Point of care devices provide rapid and reliable coagulation profile of a patient which can prove to be lifesaving in an emergency.

Keywords: Coagulation profile, Point of care, Laboratory test, Trauma, Trauma Induced Coagulopathy, DIC, Emergency department.

1. INTRODUCTION

With economic development, infrastructure upgradation and increased quality of life, the number of motor vehicles, high rise buildings and construction sites are multiplying daily. The regrettable consequence of this is polytrauma, be it due to high-speed vehicular accidents, fall from heights, impalements or other construction related injuries. Trauma induced coagulopathy (TIC) is a widely known adverse event associated with polytrauma. Early diagnosis of coagulopathy is based on the laboratory determination of activated partial thromboplastin time (APTT), prothrombin time (PT), international normalized ratio (INR), fibrinogen, and platelet count.[1-4] Specifically, an increased INR may be associated with multiple organ failure, venous thromboembolism, longer hospital stays and increased mortality due to bleeding.[5-7] The results of laboratory-based coagulation tests are often delayed, which can adversely influence patient outcome. To overcome these limitations, point of care (POC) devices have been introduced for bedside PT/ INR measurements on whole blood. Point-of-care testing (POCT) may provide a rapid, reliable, and repeatable measurement of PT/INR.[8-12] Inclusion of such devices into clinical practice could allow an early diagnosis of deranged coagulation status and initiation of the timely therapy, which might increase the survival of the patients.[7] Most existing POC devices were developed to monitor INR in patients on anticoagulant therapy.[8-9] Only a few authors have evaluated such devices for the diagnosis of coagulopathy in trauma settings.[10-12] In these studies, coagulation parameters obtained by POC devices were seen to provide a significant gain in time compared with central laboratory results and they showed moderate performance in diagnosing coagulopathy in trauma patients. Our study aims to correlate the coagulation markers performed by POC devices with those performed by conventional laboratory methods.

Corresponding Author:** ***Dr. Santvana Kohli,
Department of Anaesthesia and Intensive Care, Vardhman Mahavir Medical College and Safdarjung Hospital, New Delhi, India.

MATERIALS AND METHODS

Study design and study population

A prospective observational study was conducted in the emergency department (ED) of the authors' hospital over a period of three months, after approval from institutional ethical committee and CTRI registration. Included in the study were all trauma patients aged 18-65 years admitted with one or more of the following injuries - traumatic brain injury with a GCS Glasgow Coma Scale (GCS) score <13, chest trauma, abdominal injury, pelvic or long bone fractures. A written informed consent was taken from patients or next of kin, whichever was applicable. Pregnant females, patients withknown haemorrhagic and hepatic disorders, history of blood transfusion in the last 72 hours, or patients on anticoagulant and antiplatelet therapy were excluded from the study.

Methodology

Upon admission, polytrauma patients were managed as per the latest Acute Trauma Life Support (ATLS) protocol. Primary survey was done, standard monitors (electrocardiography, non-invasive blood pressure, pulse oximetry) were attached and findings recorded. Two wide bore intravenous lines were secured and blood samples drawn. For our study purpose, approximately 20 microlitres of blood were dispensed into PT INR cartridges of the Abbott iSTAT™ POC device. The

iSTAT PT/INR measurement was performed with a recombinant tissue factor reagent with an ISI of 1.05. The remaining blood sample was sent to the lab in a citrated tube for coagulation studies (PT, APTT & INR). Laboratory measurement of coagulation parameters was performed using the ACL Elite pro coagulation analyser with the reagent thromboplastin of human origin with an ISI of 1.06. A cut-off of INR > 1.5 was taken for the diagnosis of coagulopathy in trauma patients.[6]Coagulopathy was managed as per our institutional protocol. Following fluid resuscitation, repeat coagulation testing was done by POC device and conventional laboratory method.Time taken for results from both methods was noted. Management of trauma patients continued simultaneously as per ATLS guidelines.

POC device description

The POC device used in our study is Abbott iSTAT^{TM}. It is a portable device, designed to perform multiple bedside blood investigations, as per the disposable cartridge inserted. It works at the temperature range of 16^0-30^0C.A single-use disposable cartridge contains micro fabricated sensors, a calibrant solution, a fluidics system, and a waste chamber. A fresh whole blood sample, without any anticoagulant in syringe, (approximately one to three drops) is dispensed into the cartridge sample well. The sample well is sealed before inserting it into the analyzer. The test determines the time required for complete activation of the extrinsic pathway of the coagulation cascade when activated using recombinant tissue factor reagent with an ISI of 1.05. The reportable INR range is 0.9 – 8.

Statistical Analysis

The study of Mistral T *et al* observed that Pearson's coefficient of correlation between POC and lab INR measurements was 0.44 in trauma patients.[10] Taking these values as a reference, the minimum sample size taken was 50 with 90% power of the study, 95% confidence interval, alpha error = 0.05 & beta error = 0.1. The data was entered in an MS Excel spreadsheet and analysis was done using the latest version of Statistical Package for Social Sciences (SPSS) version 21. Descriptive analysis was done using the median (25^{th}-75^{th} percentile) for continuous variables and frequency (%) for qualitative variables. The graphical representation was done using appropriate tools. Correlation between POC PT/INR and lab PT/INR was measured using Pearson's or Spearman's correlation coefficient. The sensitivity and specificity of the POCT PT/INR were taken out. A p-value < 0.05 was considered significant.

RESULTS

Our study included 60 adult trauma patients at the start. Ten patients were subsequently excluded from the final analysis due to missing lab PT/INR values (three patients), blood clots in lab samples (four patients), and error reported in POC PT/INR values (three patients). Majority of the study participants (82%) were in the age group of 20 to 39 years. Males constituted 80% of the study population. The most common cause of trauma observed was road traffic accidents (74%), followed by physical assault and fall from height. Patient characteristics upon admission are summarized in Table 1. The mean value of POCT INR was 1.29 with a standard deviation of 0.447 and laboratory INR was 1.27 with an standard deviation of 0.3446.At the time of admission, the correlation between lab-INR & POC-INR measurements was found to be moderately positive with Pearson's coefficient (r-value) equal to +0.66 (Figure 1) and strongly positive with r-value equal to +0.762 after fluid resuscitation (Figure 2). The average correlation between these two methods was +0.71 (strongly positive) and was found to be statistically highly significant ($p < 0.001$).

Table 1. Patient characteristics (*n*=50). Data are presented as mean for age (range), median (interquartile range) & absolute (%) for all other variables

Variables	All patients (*n*=50)
Male gender	40(80%)
Age (years)	37(28-45)
Systolic arterial pressure (mmHg)	110 (92-120)
Heart rate (beats min^{-1})	90 (80-100)
Lactate (mmol $litre^{-1}$)	1.2 (1-1.31)
pH	7.38 (7.36-7.4)
Hb (g dl^{-1})	11 (9-12)
Temperature (°F)	97.5(97-98)
Platelets (10^3 μl^{-1})	211(155-300)
POC INR (before resuscitation)	1.1(1-1.4)
Laboratory INR (before resuscitation)	1.17(1.07-1.4)
POC INR (after resuscitation)	1.13 (1-1.3)
Laboratory INR (after resuscitation)	1.22(1.09-1.45)
GCS	9(7-12)

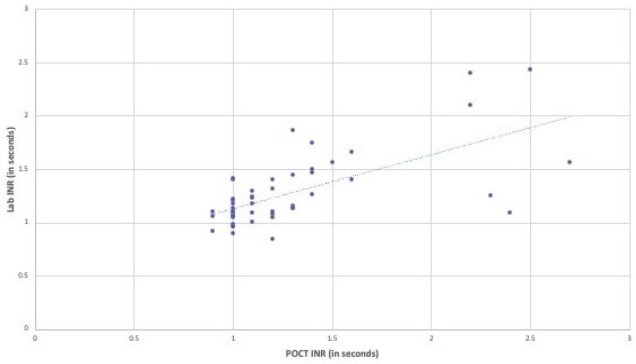

Figure 1. Represents the correlation between POC INR and Lab INR of patients before resuscitation. It is a scatter plot of POC INR values on the x-axis against Lab INR values on the y-axis for the 50 patients. The correlation between these values was found to be moderately positive with Pearson's coefficient (r-value) equal to +0.656 and was found to be statistically very highly significant (p<0.001). The dotted line represents the linear relationship between POCT INR and Lab INR values

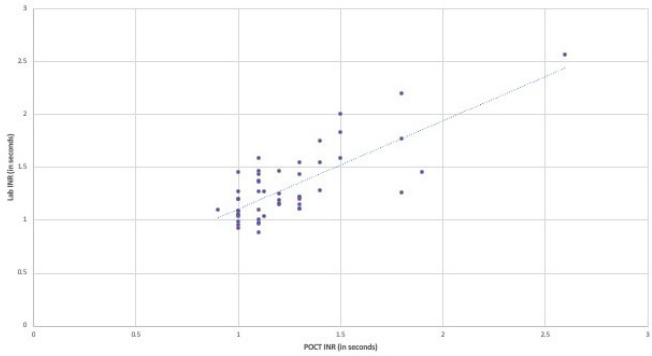

Figure 2. Represents the correlation between POC INR and Lab INR of patients after resuscitation. It is a scatter plot of POC INR values on the x-axis against Lab INR values on the y-axis for the 50 patients. The correlation between these values was found to be strongly positive with Pearson's coefficient (r-value) equal to +0.762 and was found to be statistically very highly significant (p<0.001). The dotted line represents the linear relationship between POCT INR and Lab INR values

The sensitivity, specificity, positive predictive value (PPV), and negative predictive values (NPV) of the POC device were found to be 62.5%, 92.9%, 62.5%, and 92.9% respectively (Tables 2 & 3). The average time taken for laboratory and POC results were 3 ±1 hours & 4 ± 1 minutes respectively. The difference between time taken was also highly significant statistically ($p < 0.001$).

Table 2. POC INR correlation with lab INR when INR >1.5 considered as coagulopathy

		LAB INR		Total
		>1.5 (coagulopathy)	≤1.5 (no coagulopathy)	
POCT INR	>1.5	5 (True positive)	3 (False positive)	8
	≤1.5	3 (False negative)	39 (True negative)	42
	Total	8	42	50

Table 3. Sensitivity, specificity, positive and negative predictive values of POCT INR at the time of admission

POC INR	Estimate
Sensitivity (%)	62.5
Specificity (%)	92.9
PPV (%)	62.5
NPV (%)	92.9

DISCUSSION

Trauma patients are a sizeable subset of patients presenting to the ED. These patients are often young, have no or minimal comorbidities and present with a potentially reversible condition if timely and appropriate interventions are instituted. For this reason, early detection of potential complications, such as TIC, can have a huge impact on patient outcome. Conventionally, blood samples drawn in ED are sent to central laboratory for haematological investigations, including coagulation profile. The results of these investigations are usually available after at least three to four hours later in a big teaching hospital like ours with a massive patient load.

The introduction of POC devices such as Abbott iSTAT™ to our ED and other emergency areas like intensive care units and emergency operation theatres has brought laboratory services to the patient bedside and has made patient management easier and faster. The devices are usually hand held and have a variety of single-use cartridges for specific group of blood investigations such as coagulation profile, blood gas analysis, complete haemogram, blood biochemistry and cardiac markers amongst many others. The quantity of whole blood required in the cartridge for testing is miniscule, and no anticoagulant filled vacutainers are needed. The POC devices are easy to clean and also have means for internal and external calibration. These devices are calibrated for normal platelet counts and haematocrit and they use whole blood for PT/INR analysis, whereas central laboratory INRs are measured on plasma. After major trauma, a decrease in platelet count or haematocrit may interfere with POC measurements. In the laboratory, platelet-depleted plasma is used for analysis which may decrease inter-individual differences induced by changes in platelet count. This may be the reason for moderate correlation between the two methods at the time of admission (Pearson coefficient, $r = +0.66$) in our study. The correlation was found to be better after resuscitation ($r = +0.762$), which may be due to early replacements of blood products in actively bleeding patients. A similar study conducted by Mistral T*et al* on 98 patients found that the correlation between POC INR and Lab INR was weak with an r-value of +0.44.[10] The POC device used in their study was Coagucheck ® XS pro. These results are different from our study, possible because of a different POC devices used, study population size, technical failure with the device, and requirement of frequent calibrations. Contrary to this, a strong correlation was observed between POC INR and laboratory INR in a study conducted by Weyrauch*et al*.[11] These results could be explained by a larger sample size (177 trauma patients), and the difference in calibration and technique. Similarly, a study conducted by Gauss T *et al* on 39 patients demonstrated a moderate correlation between POCT INR and Lab INR with an r-value of +0.68.[12] The POC device used in their study was Hemochron Signature Elite ®. The device exhibited sensitivity, specificity, and positive & negative predictive values of 83%, 70%, 76% & 77% respectively. These results were comparable to our study findings. We acknowledge several limitations in ours study. Firstly, we could only consider only 50 out of 60 patients for analysis. Hence, our sample size was small. Secondly, our study device required calibration at least 2 to 3 times per day for better results. Thirdly, very few patients had an increased INR value of >1.5 and the sensitivity of our POC device was low.

Conclusion

We conclude that a POC coagulation device may effectively be used to assess the coagulation status in trauma patients in the ED, which would guide us to take an early decision for the initiation of blood transfusion in trauma-induced coagulopathy patients.

REFERENCES

1. Chang R, Cardenas JC, Wade CE, Holcomb JB. Advances in the understanding of trauma-induced coagulopathy. Blood. 2016;128(8):1043-9. doi: 10.1182/blood-2016-01-636423. *Epub* 2016 Jul 5. PMID: 27381903; PMCID: PMC5000842.
2. Simmons JW, Powell MF. Acute traumatic coagulopathy: pathophysiology and resuscitation. *Br J Anaesth*. 2016;117(suppl 3):iii31-iii43. doi: 10.1093/bja/ aew328.
3. Hess JR, Brohi K, Dutton RP, et al. The coagulopathy of trauma: a review of mechanisms. *J Trauma.* 2008;65(4):748-54. doi: 10.1097/TA.0b013e3181877a9c. PMID: 18849786.
4. Rossaint R, Bouillon B, Cerny V, et al. The European guideline on management of major bleeding and coagulopathy following trauma: fourth edition. *Crit Care.* 2016;20:100. doi: 10.1186/s13054-016-1265-x. PMID: 27072503; PMCID: PMC4828865.
5. Peltan ID, VandeVusse LK, Maier RV, Watkins TR. An International Normalized Ratio-Based Definition of Acute Traumatic Coagulopathy Is Associated With Mortality, Venous Thromboembolism, and Multiple Organ Failure After Injury. *Crit Care Med.* 2015;43(7):1429-38. doi: 10.1097/CCM.0000000000000981. PMID: 25816119; PMCID: PMC4512212.
6. Frith D, Goslings JC, Gaarder C, et al. Definition and drivers of acute traumatic coagulopathy: clinical and experimental investigations. *J Thromb Haemost.* 2010;8(9):1919-25. doi: 10.1111/j.1538-7836.2010.03945. x. PMID: 20553376.

7. Gunter OL Jr, Au BK, Isbell JM, Mowery NT, Young PP, Cotton BA. Optimizing outcomes in damage control resuscitation: identifying blood product ratios associated with improved survival. *J Trauma*. 2008;65(3):527-34. doi: 10.1097/TA.0b013e3181826ddf. PMID: 18784564.
8. Bauman ME, Black KL, Massicotte MP, et al. Accuracy of the CoaguChek XS for point-of-care international normalized ratio (INR) measurement in children requiring warfarin. *Thromb Haemost*. 2008;99(6):1097-103. doi: 10.1160/TH07-10-0634. PMID: 18521514.
9. Maddox JM, Bogo PH, McGregor E, Pippard MJ, Kerr R. Quality assurance for point-of-care testing of oral anticoagulation: a large-scale evaluation of the Hemochron Junior Signature Microcoagulation System. *Int J Lab Hematol.* 2009;31(2):142-50. doi: 10.1111/j.1751-553X.2007.01013.x. Epub 2007 Dec 20. PMID: 18177437.
10. Mistral T, Boué Y, Bosson JL, et al. Performance of point-of-care international normalized ratio measurement to diagnose trauma-induced coagulopathy. *Scand J Trauma Resusc Emerg Med.* 2017;25(1):59. doi: 10.1186/s13049-017-0404-y. PMID: 28637514; PMCID: PMC5480161.
11. Weyrauch E, Walliser G, Hartwell J. Point-of-care international normalized ratio testing is rapid and reliable: A prospective observational cohort study. *Int J Acad Med.* 2016;2(1):27-31. doi: 10.4103/2455-5568.183322.
12. Gauss T, Hamada S, Jurcisin I, et al. Limits of agreement between measures obtained from standard laboratory and the point-of-care device Hemochron Signature Elite(R) during acute haemorrhage. *Br J Anaesth*. 2014;112(3):514-20. doi: 10.1093/bja/aet384. Epub 2013 Dec 12. PMID: 24335551.

****