The Practicalities and Barriers of Using TEG6s in Code Red Traumas:

An Observational Study in One London Major Trauma Centre

Running Title: Practicalities of Using TEG6s in Trauma

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Background

Trauma-induced coagulopathy (TIC) is a disorder of the coagulation pathway that occurs following a major trauma and is associated with increased mortality and morbidity.<1> Thromboelastography (TEG) is one method of assessing for TIC. Studies have suggested that TEG can identify TIC and may be useful for predicting blood-component transfusion.<2-4> TEG6s (Haemonetics®) is a cartridge-based system which the company claims is more reproducible compared to previous models.

Trauma resuscitations, normally activated by the ambulance service as per their guidelines, within St George's hospital are led by emergency department (ED) consultants or registrars as the trauma team leader (TTL). If major haemorrhage is suspected, either on arrival in hospital or pre-hospital, a "code red" trauma is activated, allowing immediate access to blood products; the TTL guides any blood components which are transfused according to the TTL request. The kaolin activated TEG assay, included in the hospital's guidelines, uses the TEG 5000 machines (Haemonetics®) situated in intensive care and is rarely performed. ED staff's understanding and knowledge of TIC and TEG is unclear.

This study aimed to qualitatively establish the reasons TEG is not currently utilised and the ongoing practicalities in performing a TEG sample within the resuscitation room of an Emergency Department of one London Major Trauma Centre.

Methods

This pilot study was carried out at one London Major Trauma Centre. A trial period was arranged for a TEG6s to be placed within the resuscitation room to assess utilisation of TEG; there was no obligation to purchase.

All ED staff were made aware of the TEG6s with demonstrations on its use at the start of the trial. Staff were encouraged to run a TEG sample on any code red patient who attended during the trial period (December 2016-Janaury 2017 inclusive). The results were available to the TTL to use as they felt appropriate (as would have been the case if a TEG sample had been run elsewhere).

Prior to the introduction of the TEG machine, a questionnaire was distributed by hand to doctors and nurses within the ED to establish current knowledge around TEG. The questionnaire was distributed over the course of several days by one author to ensure suitable representation of ED staff (approximately 50% of staff employed in the ED at that time). Following the trial, all staff who had run a TEG sample during the trial were contacted for their feedback via an online questionnaire (contact details were recorded at the time of running the TEG). A second questionnaire was distributed within the ED asking for the wider staff's opinion on the use of TEG in the same manner as the initial questionnaire; staff initially surveyed were re-surveyed where possible. (Questionnaires in Appendix 1).

Ethical approval was not required as there was no change in current practice or the established code red protocol (Appendix 2).<5> Data were recorded and analysed in Microsoft Excel 2016 and handled in keeping with information governance regulations.

Results

During the trial, there were 16 code red activations. A TEG sample was performed in 75% of cases, with one sample being unsuccessful (69% success rate overall - Appendix 3). The results relating to pre-trial TEG awareness are demonstrated in Table 1. Of the five members of staff who utilised a TEG6s during the trial, all managed to peform the TEG6s successfully and stated they found it easy to use. (One person who ran a TEG6s could not be contacted; this related to the unsuccessful sample). Blood components for one patient were prescribed based on the TEG result. Following the trial period, the results relating to the TEG machine and knowledge surrounding it in the ED are shown in Table 1.

Table 1: Knowledge relating to TIC and TEG

Staff Role	Number of Staff Pre-trial	Number who had heard of TIC pre-trial	Number who understand what TIC is pre-trial	Number of staff who heard of TEG pre-trial	Number of Staff Post-trial	Number of staff who felt TEG could be utilised in the resuscitation room post-trial	Number of staff who felt confident in interpreting TEG results post-trial	Number of staff that felt TEG results would guide blood component management based on their current knowledge post-trial
Band 5 nurse	20	8	7	5	16	16	3	7
Band 6 nurse	6	6	6	6	8	8	2	5
Band 7 nurse	3	1	0	1	3	3	1	0
Medical Assistant	4	1	0	2	2	1	0	0
Matron	1	1	1	0	0	N/A	N/A	N/A
Senior House Officer*	17	12	8	6	7	7	1	3
Registrar	4	4	4	4	10	10	6	8
Consultant	3	3	3	3	6	6	2	4
Total	**58**	**36 (62%)**	**29 (50%)**	**27 (47%)**	**52**	**51 (98%)**	**15 (29%)**	**27 (52%)**

**Senior House Officer includes Foundation Year 2 (F2), clinical fellow and core trainees; F2 doctors are in their second year after qualifying from medical school; core trainees have chosen specialist training in emergency medicine. Registrars have completed their initial emergency medicine examinations (within the UK Membership of the Royal College of Emergency Medicine). Band 5 nurses are nurse that have completed their initial nursing qualification. Band 6 and 7 nurses are more senior nurses.*

Discussion

This study demonstrated that it is possible to run TEG6s samples within an ED but there is a lack of education relating to TIC and the interpretation of TEG results; this is an important barrier to TEG utilisation and is likely to hinder its impact on personalising blood component management.

Only one patient had their blood component management altered due to the TEG result as there was a lack of confidence amongst clinicians in interpreting results; only 8 of 16 consultants and registrars surveyed felt confident in interpreting TEG results. This is consistent with a study which found only 11% of doctors correctly estimated the number of patients with TIC.<6> Our work is also similar to another investigation that concluded emergency physicians lack core knowledge about the use of blood and blood components in the context of major haemorrhage following trauma.<7> It would therefore appear that more research into how best to educate staff on the use, value and interpretation of TEG is required. Unless this is performed we are unlikely to see TEG results being used to guide blood-component transfusion as the literature states it has the potential to.<3, 8>

Limitations

This study was based at one London Major Trauma Centre only and may not reflect the findings of other centres. However, the majority of doctors included will have worked at other EDs in the UK and abroad and so results may not be dissimilar in other centres. There was also only a limited number of staff who were required to run a TEG during the trial period, which may limit its generalisability; however, it may be that the same staff consistently run a TEG as a result of the trauma team protocol.

Conclusion

Viscoelastic haemostatic assays, in particular TEG6s, are likely to be useful in guiding blood component support in a timely manner during the initial resuscitation phase of a trauma patient. However, considerable education is required to make practical use of the TEG result. Until knowledge regarding TEG and its interpretation becomes more widespread, then TEG, or indeed similar point-of-care testing, is unlikely to be utilised to fully benefit patients.

Author Contribution

All authors were involved in the development of this study and its design. SM undertook the literature search, writing and critical revision of the manuscript. JG undertook data interpretation and critical revision. JG and JU were involved in data interpretation. JU and AH were involved in critical revisions of the manuscript.

References

1. Brohi K, Singh J, Heron M, Coats T. Acute traumatic coagulopathy. *J Trauma*. 2003;54(6):1127-30.

2. da Luz LT, Nascimento B, Rizoli S. Thromboelastography (TEG®): practical considerations on its clinical use in trauma resuscitation. *Scand J Trauma Resusc Emerg Med*. 2013:21:29.

3. Tapia NM, Chang A, Norman M, Welsh F, Scott B, Wall MJ, et al. TEG-guided resuscitation is superior to standardized MTP resuscitation in massively transfused penetrating trauma patients. *J Trauma Acute Care Surg*. 2013;74(2):378-85.

4. Nystrup KB, Windelov NA, Thomsen AB, Johansson PI. Reduced clot strength upon admission, evaluated by thrombelastography (TEG), in trauma patients is independently associated with increased 30-day mortality. *Scand J Trauma Resusc Emerg Med*. 2011;19:52.

5. Health Research Authority. Is my study research? : Medical Research Council; 2017 Available from: http://www.hra-decisiontools.org.uk/research/result7.html. [Accessed May 12, 2017]

6. Jeger V, Urwyler N, Zimmermann H, Exadaktylos AK. Trauma-induced coagulopathy in severely injured patients: knowledge lost in translation? *Emerg Med J*. 2010;27(7):551-2.

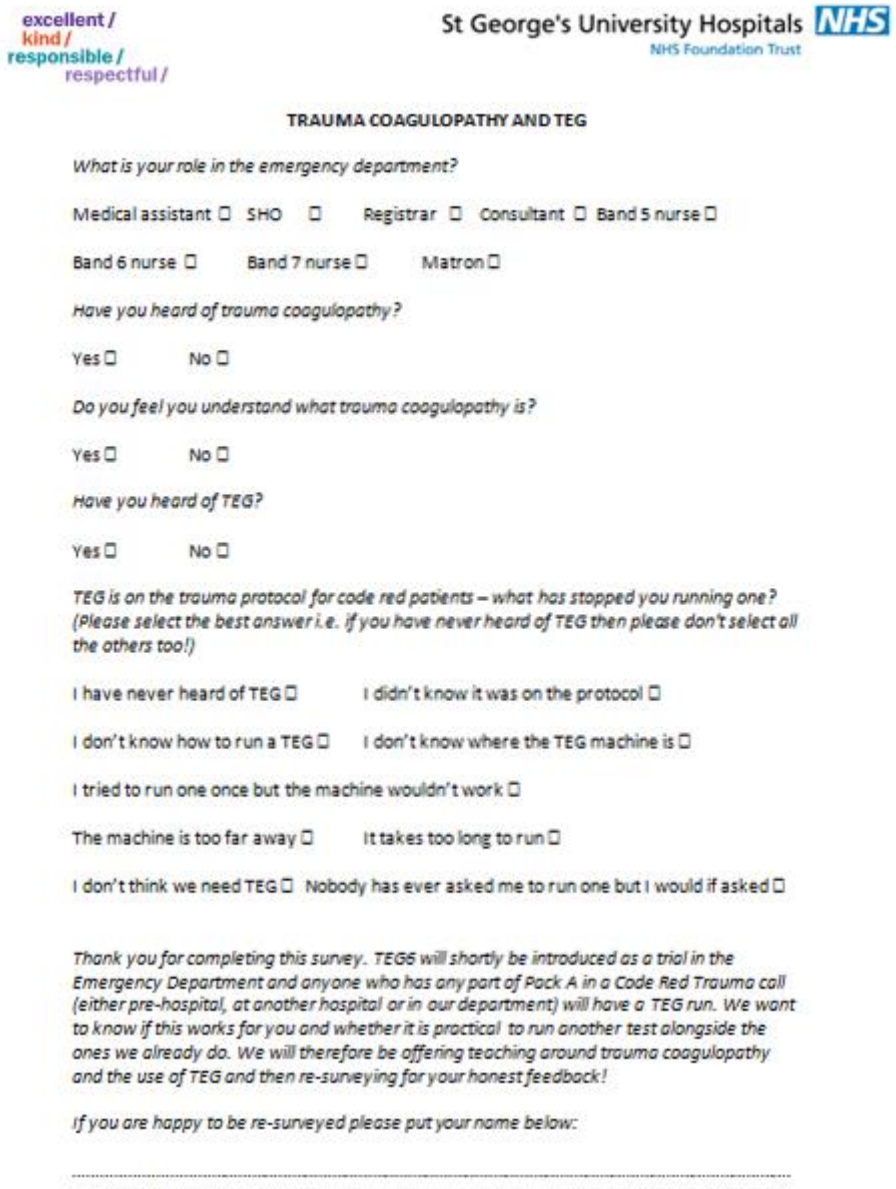
7. Milligan C, Higginson I, Smith JE. Emergency department staff knowledge of massive transfusion for trauma: the need for an evidence based protocol. *Emerg Med J*. 2011;28(10):870-2.

8. Holcomb JB, Minei KM, Scerbo ML, Radwan ZA, Wade CE, Kozar RA, et al. Admission Rapid Thrombelastography Can Replace Conventional Coagulation Tests in the Emergency Department Experience With 1974 Consecutive Trauma Patients. *Ann Surg.* 2012;256(3):476-86.

Acknowledgements

Our thanks go to Haemonetics who lent the TEG6s machine to the department on a trial basis. They did not have any involvement in the collection or analysis of this data. The cartridges required for the TEG6s were donated by Haemotinics.

Appendix 1



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TRAUMA COAGULOPATHY AND TEG

What is your role in the emergency department?

Medical assistant ☐ SHO ☐ Registrar ☐ Consultant ☐ Band 5 nurse ☐

Band 6 nurse ☐ Band 7 nurse ☐ Matron ☐

Have you heard of trauma coagulopathy?

Yes ☐ No ☐

Do you feel you understand what trauma coagulopathy is?

Yes ☐ No ☐

Have you heard of TEG?

Yes ☐ No ☐

TEG is on the trauma protocol for code red patients – what has stopped you running one? (Please select the best answer i.e. if you have never heard of TEG then please don't select all the others too!)

I have never heard of TEG ☐ I didn't know it was on the protocol ☐

I don't know how to run a TEG ☐ I don't know where the TEG machine is ☐

I tried to run one once but the machine wouldn't work ☐

The machine is too far away ☐ It takes too long to run ☐

I don't think we need TEG ☐ Nobody has ever asked me to run one but I would if asked ☐

Thank you for completing this survey. TEG6 will shortly be introduced as a trial in the Emergency Department and anyone who has any part of Pack A in a Code Red Trauma call (either pre-hospital, at another hospital or in our department) will have a TEG run. We want to know if this works for you and whether it is practical to run another test alongside the ones we already do. We will therefore be offering teaching around trauma coagulopathy and the use of TEG and then re-surveying for your honest feedback!

If you are happy to be re-surveyed please put your name below:

.....

Figure 1: Pre-Trial Questionnaire

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TEG

What is your role in the emergency department?

Medical assistant ☐ SHO ☐ Registrar ☐ Consultant ☐ Band 5 nurse ☐

Band 6 nurse ☐ Band 7 nurse ☐ Matron ☐

Did you use or ask for a TEG sample to be run in the past 2 months?

Yes ☐ No ☐ No because I had no code red traumas but I would like to in the future ☐

Do you feel the TEG result has a place in the resus room for trauma patients?

Yes ☐ No ☐

Do you feel that TEG has applications outside of trauma?

Yes ☐ No ☐

Do you feel confident that you would be able to interpret and use a TEG result accordingly?

Yes ☐ No ☐

Do you believe that using a TEG would guide you with blood products?

Yes ☐ No ☐ I don't think I know enough about it yet ☐

Where do you believe the TEG6 should be located?

ED resus ☐ Theatres ☐ ITU ☐ The lab ☐

I don't think we should have one ☐

Other (please specify).....

Finally, please give us your opinion on TEG in the ED including whether you believe it is useful, whether you believe it will guide your transfusions and whether you feel it is a worthwhile investment or not. Please be honest with your feedback (please turn over if necessary).

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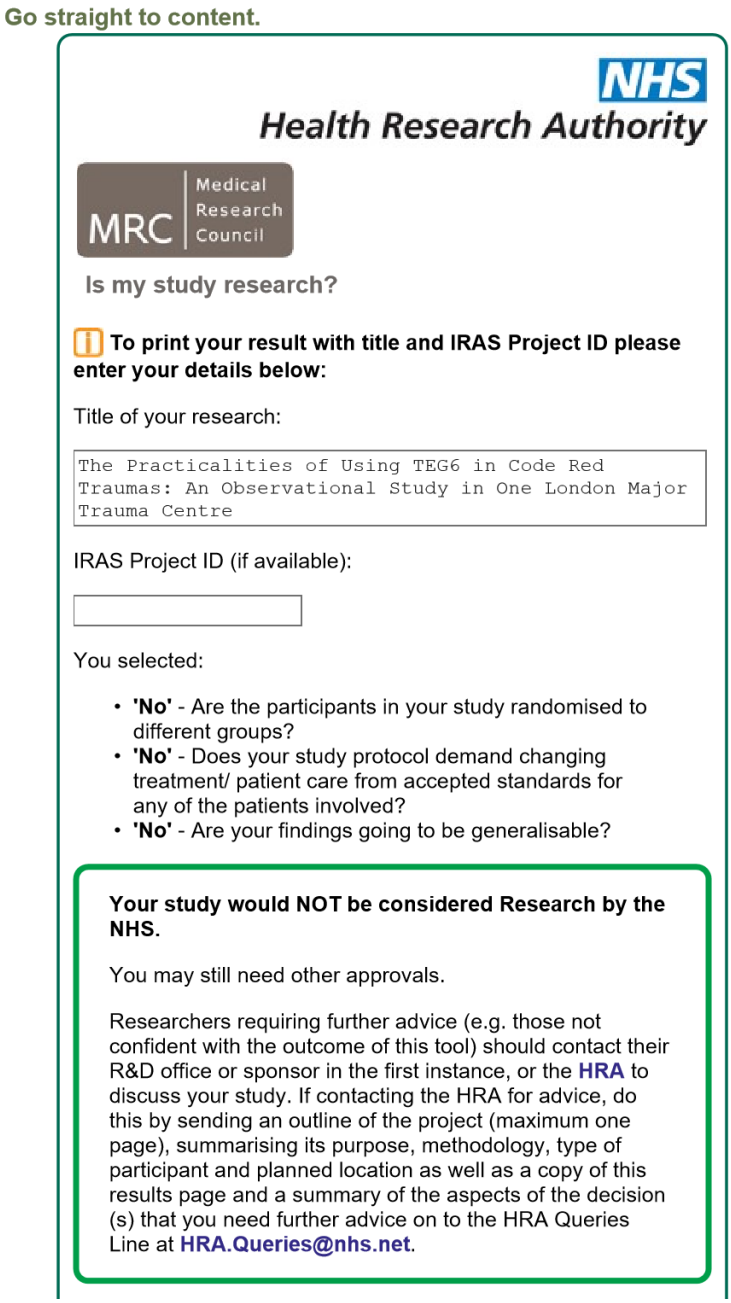
Figure 2: Post trial questionnaire

Appendix 2



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Title of your research:

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IRAS Project ID (if available):

You selected:

- **'No'** - Are the participants in your study randomised to different groups?
- **'No'** - Does your study protocol demand changing treatment/ patient care from accepted standards for any of the patients involved?
- **'No'** - Are your findings going to be generalisable?

Your study would NOT be considered Research by the NHS.

You may still need other approvals.

Researchers requiring further advice (e.g. those not confident with the outcome of this tool) should contact their R&D office or sponsor in the first instance, or the **HRA** to discuss your study. If contacting the HRA for advice, do this by sending an outline of the project (maximum one page), summarising its purpose, methodology, type of participant and planned location as well as a copy of this results page and a summary of the aspects of the decision (s) that you need further advice on to the HRA Queries Line at **HRA.Queries@nhs.net**.

Appendix 3

Table 1: Results of TEG-6 run during the trial period on Code Red Patients

Patient	Sex	Age	Injury Severity Score	Number of TEGS run	TEG results	INR result	Blood components given*	On review of TEG results by consultant haematologist following trial, could blood product administration have been altered at the time of the TEG?	Patient Outcome
1	F	80	22	1	Normal	1.0	3 PRC/2 FFP	No	Survived
2	M	28	9	1	Mildly hypercoagulable	1.1	Not available	No	Survived
3	M	51	17	1	Normal	0.9	0	No	Survived
4	M	94	29	1	Test failed	1.0	4 PRC/4FFP	No	Deceased
5	M	82	N/A¶	1	Normal	NO RESULTS	2 PRC	No	Deceased
6	M	26	Awaiting	1	Normal	0.9	1 PRC	No	Survived
7	F	92	34	1	Mildly hypercoagulable	1.0	1 PRC	No	Deceased
8	F	86	22	1	Mild coagulopathy	1.1	4 PRC/2 FFP	Advise plasma	Deceased
9	M	16	35	1	Coagulopathic	1.4	4 PRC/4FFP	Advise fibrinogen replacement	Survived
10	M	46	9	1	Normal	1.1 (initial result was no result)	3PRC/3FFP	No	Deceased
11	M	33	43	2	Coagulopathic	1.2	4 PRC/3FFP/1 Plts/2 cryo	Advise further fibrinogen replacement**	Deceased
12	M	61	66	1	Coagulopathic	1.3	4PRC/4FFP	Advise fibrinogen replacement	Deceased

PRC = packed red cells; FFP = fresh frozen plasma; cryo = cryoprecipitate; Plts = platelets
**Blood components administered within the emergency department. Some patients went on to have further components.*
¶Patient had a road traffic accident secondary to abdominal aortic aneurysm so no severity of trauma score. No blood results formally taken.
***Patient's blood components were guided by results of first TEG. Second TEG result suggested fibrinogen deficiency.*