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SHORT COMMUNICATION

Current practice of periprocedural haematological management for patients undergoing image-guided procedures

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Objective: To evaluate current UK practice of periprocedural haematological management for image-guided procedures in relation to Cardiovascular and Interventional Radiological Society guidelines, which provide recommendations according to bleeding risk of procedures from Category 1 (lowest) to 3 (highest).

Methods: Survey of practice in UK radiology departments conducted over a 1-year period

Results: 48 radiology departments responded. The percentage of departments that stop antithrombotics pre-procedurally are as follows (for Category 1, 2 and 3, respectively): aspirin (31.3%, 43.8%, 54.2%); clopidogrel (54.2%, 68.8%, 72.9%); therapeutic low-molecular-weight heparin (56.3%, 77.1%, 75.0%). The percentage of departments that perform pre-procedural laboratory testing are as follows (for Category 1, 2 and 3, respectively): international normalized ratio (INR; 81.3%, 95.8%, 93.8%); activated partial thrombin time ratio (APTT; 60.4%, 75.0%, 93.8%); platelet (77.1%, 91.7%, 95.7%); haemoglobin (70.8%, 85.4%, 87.5%). Mean threshold (standard

deviation) of laboratory results for conducting procedures (Level 1, 2 and 3, respectively) are as follows: INR [1.53 (0.197), 1.47 (0.186), 1.47 (0.188)]; APTT [1.50 (0.392), 1.50 (0.339), 1.48 (0.344)]; platelet count ($\times 10^3$ cells per microlitre) [74.4 (28.7), 79.9 (29.1), 80.5 (29.3)]; haemoglobin (grams per decilitre) [9.05 (1.40), 9.00 (1.33), 8.92 (1.21)]. No department practices conformed to current recommendations for (1) pre-procedural cessation of antithrombotics and (2) pre-procedural laboratory testing. Two (4.2%) department practices conformed to recommendations for thresholds of haematological parameters.

Conclusion: Current peri-procedural haematological management is variable and often does not conform to existing recommendations. Further research into the impact of this variation in practice on patient outcome is required

Advances in Knowledge: This study demonstrates wide variation in practice in haematological management for image-guided procedures.

Periprocedural haematological management, such as correction of coagulopathy, cessation of antithrombotics and pre-procedural laboratory testing (e.g. for haemoglobin levels and platelet count), is an important consideration for patients undergoing image-guided procedures.¹ The challenges of periprocedural haematological management are multifactorial in aetiology. In addition to the increasing range of complex image-guided procedures being performed, the patient population undergoing such procedures may also be complicated.² Many of these patients have comorbidities requiring antithrombotic therapy, or may have liver and marrow dysfunction, which can affect bleeding risk. Decisions on the optimal periprocedural haematological management are also confounded by the lack of high-level evidence, and existing guidelines within the literature can be

variable even for equivalent procedures. For example, in two separate internationally accepted guidelines, the recommended international normalized ratio (INR) for chest drain insertion is <1.5 and <2.0 .^{3,4} There is also limited scope to transfer existing evidence on haematological management from other domains such as open surgery to image-guided interventions. Unlike conventional open surgical procedures where bleeding may be visualized immediately and controlled by direct pressure or vessel ligation, bleeding from image-guided procedures may be difficult to control owing to issues with access and identification.⁵

The lack of high-level evidence is unsurprising, given the potential ethical issues in conducting the necessary studies; it would be difficult to justify the randomization of patients to

receiving or not receiving coagulopathy correction prior to undergoing various image-guided procedures for the purpose of research.⁶ As a result, current evidence is often based on retrospective studies. To address this complex issue, the Society of Interventional Radiology in conjunction with the Cardiovascular and Interventional Radiological Society of Europe (CIRSE) has previously produced guidelines based on existing evidence and expert consensus on periprocedural haematological management for image-guided procedures which are stratified into three categories according to the bleeding risk (Table 1).⁴ However, despite the existence of such guidelines, from our experience, significant variation in practice exists between clinicians, even within our own institution.

The aim of this study was to evaluate current practices of haematological management in patients undergoing image-guided procedures in the UK.

METHODS AND MATERIALS

Over a 1-year period (November 2012 to November 2013), questionnaires were sent to 80 radiology departments within the Acute National Health Service (NHS) Trusts in the UK (including Scottish health boards). The questionnaire aimed to review current

practices in three key areas: (1) cessation of antithrombotics; (2) pre-procedural laboratory testing (e.g. platelet count, INR); and (3) criteria for withholding procedures or correcting parameters (e.g. platelet count, INR) (Appendix A). Questionnaires were completed by a single healthcare professional (radiologist, radiographer or nurse) with an understanding of local practices and policies within each trust. Local departmental practices were compared with CIRSE guidelines (Table 1). Where the CIRSE guidelines stated no consensus or recommendation, such as for activated partial thrombin time ratio (APTTR) and haemoglobin thresholds for withholding procedures, departments were considered to conform to CIRSE guidelines regardless of their practices.

Statistical analyses were performed using SPSS® statistics v. 22.0 (IBM Corporation, Armonk, NY). An α level of 0.05 was used to determine statistical significance. Following the review by our research and development department, the formal ethics review was waived as the study was classed as evaluation and audit.

RESULTS

Responses were acquired from 48 radiology departments of Acute NHS Trusts (60% response rate). 30 (62.5%) departments

Table 1. Society of Interventional Radiology/Cardiovascular and Interventional Radiological Society of Europe consensus guidelines on periprocedural haematological management for image-guided procedures according to category of bleeding risk

Guideline item	Guidance according to category of bleeding risk		
	Category 1 (low risk)	Category 2 (intermediate risk)	Category 3 (high risk)
Examples of procedures			
Vascular	Venography, IVC filter, PICC line	Arterial intervention (access size up to 7 French), chemoembolization, uterine fibroid embolization	TIPS
Non-vascular	Thoracentesis, paracentesis, superficial aspiration and biopsy	Intra-abdominal abscess drainage, lung biopsy, percutaneous cholecystostomy	Renal biopsy, biliary interventions (new tract), nephrostomy
Antiplatelet/anticoagulation cessation			
Aspirin	Do not withhold	Do not withhold	Withhold 5-day pre-procedure
Clopidogrel	Do not withhold	Withhold 5-day pre-procedure	Withhold 5-day pre-procedure
Therapeutic LMWH	Withhold one-dose pre-procedure	Withhold one-dose pre-procedure	Withhold for 24 h/up to two doses
Pre-procedural testing			
INR	On warfarin/with liver disease	All patients	All patients
APTTR	On unfractionated heparin	On unfractionated heparin	On unfractionated heparin
Platelet count	Not routinely recommended	Not routinely recommended	All patients
Haemoglobin	Not routinely recommended	Not routinely recommended	All patients
Threshold for correcting parameter/withholding procedure			
INR	INR >2.0	>1.5 (89% consensus)	>1.5 (95% consensus)
APTTR	No consensus	No consensus	>1.5 times control
Platelet count	Transfusion if $<50 \times 10^3 \mu\text{L}^{-1}$	Transfusion if $<50 \times 10^3 \mu\text{L}^{-1}$	Transfusion if $<50 \times 10^3 \mu\text{L}^{-1}$
Haemoglobin	No recommended threshold	No recommended threshold	No recommended threshold

APTTR, activated partial thrombin time ratio; INR, international normalized ratio; IVC, inferior vena cava; LMWH, low-molecular-weight heparin; PICC, peripherally inserted central catheters; TIPS, transjugular intrahepatic portosystemic shunt.

Adapted from Patel *et al*.⁴

Table 2. Number of departments that routinely stop antithrombotic treatment pre-procedure according the category of bleeding risk

Haematological parameter	Number of departments (%) (not applicable) ^a		
	Category 1	Category 2	Category 3
Aspirin	15 (31.3) (4)	21 (43.8) (4)	26 (54.2) (6)
Clopidogrel	26 (54.2) (4)	33 (68.8) (4)	35 (72.9) (6)
Therapeutic low-molecular-weight heparin	27 (56.3) (4)	37 (77.1) (4)	36 (75.0) (6)

^aNot applicable refers to number of departments that do not have a standard of practice for antiplatelet and anticoagulation cessation.

were tertiary referral centres for image-guided procedures. All departments surveyed performed procedures of Categories 1 and 2. 46 (95.8%) departments performed Category 3 procedures.

Results for current practice of (1) pre-procedural cessation of various antithrombotics; (2) pre-procedural haematological testing; and (3) thresholds for withholding procedure or correcting haematological parameter prior to procedure according to category of bleeding risk are presented in Tables 2–4, respectively.

30 (62.5%) departments routinely perform the same pre-procedural laboratory tests in all 3 categories of procedures. One-way analysis of variance of the threshold levels for the various laboratory tests demonstrated no significant interaction for INR ($p = 0.364$), APTTR ($p = 0.992$), haemoglobin ($p = 0.937$) and platelet ($p = 0.619$) across the three categories of image-guided procedures. Further subanalyses of individual departments' policies on thresholds for pre-procedural laboratory tests (excluding departments that have no set policy) demonstrated that 22 of 43 (51%) departments had the same INR threshold; 8 of 13 (61.5%) departments had the same APTTR threshold; 21 of 33 (63.6%) departments had the same haemoglobin level threshold; and 19 of 26 (73.1%) departments had the same platelet count threshold across the 3 categories of procedures.

With respect to the three key areas of haematological management investigated in this study, no departments' practices conformed to CIRSE recommendations for (1) pre-procedural cessation of antithrombotics and (2) pre-procedural laboratory testing. Two (4.2%) departments conformed with the recommendations for all the thresholds of haematological parameters.

DISCUSSION

This study yielded a number of interesting findings. First, there was a degree of variation in practice across the three key areas of management surveyed. The variation in practice tended to be greater for low-risk (Category 1) procedures with respect to pre-procedural testing and antithrombotic cessation. For higher risk procedures on the other hand, most departments generally conformed to CIRSE recommendations in terms of pre-procedural testing and stopping antithrombotics.

Secondly, current practices in most departments do not align with the published CIRSE guidelines. Specifically, there appears to be a tendency for departments to be over cautious. For instance, with respect to INR and platelet counts, the mean threshold employed across departments in this study for low-risk (Category 1) procedures is 1.53 and $74.4 \times 10^3 \mu\text{L}^{-1}$, respectively, both of which are closer to normal values than the thresholds recommended by CIRSE (INR, <2 ; platelet count, $>50 \times 10^3 \mu\text{L}^{-1}$). Inappropriately low thresholds can be problematic in that they may lead to unnecessary cancellations and delays in treatment, or inappropriate correction of haematological parameters (e.g. transfusion of blood products), both of which may negatively impact on patient care.

There was also a trend for departments to perform more pre-procedural tests than that recommended. For example, 70.8% and 85.4% of departments routinely tested for haemoglobin for procedures of Categories 1 and 2, respectively, despite current guidelines recommending not to. Whilst this may again be in part owing to a tendency for cautiousness, there may also be practical reasons for this. On close inspection, a large number of departments (62.5%) conducted the same pre-procedural testing across all three categories of procedures. There is, however, an

Table 3. Number of departments that perform pre-procedural haematological tests routinely according to category of bleeding risk

Haematological parameter	Number of departments (%) (not applicable) ^a		
	Category 1	Category 2	Category 3
International normalized ratio	39 (81.3) (0)	46 (95.8) (0)	45 (93.8) (2)
Activated partial thrombin time ratio	29 (60.4) (0)	36 (75.0) (0)	37 (77.1) (2)
Platelet ($\times 10^3 \mu\text{L}^{-1}$)	37 (77.1) (0)	44 (91.7) (0)	44 (91.7) (2)
Haemoglobin (g dL^{-1})	34 (70.8) (0)	41 (85.4) (0)	42 (87.5) (2)

^aNot applicable refers to number of departments that do not have a standard of practice for performing the specified haematological test pre-procedurally.

Table 4. Thresholds for various haematological parameters for withholding procedure or correcting parameter pre-procedure according to category of bleeding risk

Haematological parameter	Mean threshold level (standard deviation) (not applicable) ^a		
	Category 1	Category 2	Category 3
International normalized ratio	1.53 (0.197) (12)	1.47 (0.186) (5)	1.47 (0.188) (7)
Activated partial thrombin time ratio	1.50 (0.392) (38)	1.50 (0.339) (35)	1.48 (0.344) (35)
Platelet count ($\times 10^3 \mu\text{l}^{-1}$)	74.4 (28.7) (23)	79.9 (29.1) (15)	80.5 (29.3) (16)
Haemoglobin (g dl^{-1})	9.05 (1.40) (27)	9.00 (1.33) (21)	8.92 (1.21) (23)

^aNot applicable refers to trusts that either have no standard protocol for testing or do not laboratory test.

argument that it may be safer and easier to adopt a simpler policy, whereby all patients regardless of the type of procedure are subject to the same tests to avoid confusion.

The reasons for the observed practice variation and misalignment with published guidelines were not explored in this study. However, issues with practice variation are well-recognized throughout healthcare in general, the reasons for which are complex and include personal beliefs and biases, education and problems with policy implementation.^{7–9} With respect to the latter, issues often arise as a result of local contextual influences.¹⁰ The variation in practice is perhaps also unsurprising given the aforementioned paucity of current high-quality evidence available to guide haematological management for image-guided procedures. Regardless of the reasons, variation and discrepancy in clinical practice can be problematic and should be addressed. Aspects of policy and guidelines where the evidence is sufficiently robust should be followed. Where the evidence base for guidelines remains scarce as in certain aspects of haematological management, greater effort should be made in terms of research.

There are a number of limitations to this study. Firstly, the sample size was small, potentially limiting the generalizability of the findings. However, the sample represents approximately 25% of the total number of Acute NHS Trusts, and therefore even in

the unlikely case that all the radiology departments not surveyed conformed to the guidelines, the results still represent a significant level of non-conformance. Secondly, to maximize yield of survey responses, opportunistic sampling was utilized, potentially introducing self-selection bias. Thirdly, the results presented in this study reflect the “ideal” local practice and policy of the departments surveyed. However, this does not take into account variation in practice amongst individual radiologists within each department. As stated earlier, from our experience, there is wide variation between practitioners even within our own institution. Finally, the focus of this survey at most only highlights issues in current practices in haematological management; further studies will be necessary to determine the impact this may have on patient outcome, cost and efficiency.

In summary, the study revealed variation in practice and non-conformance to published guidelines for periprocedural haematological management of patients undergoing image-guided procedures. Although this may in part be owing to limitations in available evidence, in the absence of better quality evidence, compliance with published expert consensus guidelines should be encouraged. Further research into the aspects of haematological management where the evidence base remains scarce should at the same time be promoted.

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APPENDIX A

NATIONAL SURVEY ON CURRENT PRACTICE OF PERI-PROCEDURAL HAEMATOLOGICAL MANAGEMENT OF PATIENTS UNDERGOING PERCUTANEOUS INTERVENTIONAL RADIOLOGICAL PROCEDURES

Please read the following information before answering the questions below:

Participant information

There is currently some variation in the practice of periprocedural coagulation testing and management of patients undergoing percutaneous interventional radiology procedures. The purpose of this study is to evaluate current practices within individual NHS trusts across the UK.

Participation in this survey is on a purely voluntary basis. Participants may withdraw from the study at any point during the study time period. Trusts will be anonymised during data analysis and dissemination of findings.

This questionnaire will ask questions related to three categories of interventional procedures in terms of risk of bleeding according to the Society of Interventional Radiology as follows:

The Society of Interventional Radiology currently stratify percutaneous interventional radiology procedures according to risk of bleeding as follows with examples of the types of procedures:

Category 1: Procedures with Low Risk of Bleeding, Easily Detected and Controllable

Vascular: Dialysis access interventions, Venography, Central line removal, IVC filter placement, PICC line placement

Nonvascular: Drainage catheter exchange (biliary, nephrostomy, abscess catheter), Thoracentesis, Paracentesis, Superficial aspiration and biopsy (excludes intrathoracic or intraabdominal sites): thyroid, superficial lymph node, Superficial abscess drainage

Category 2: Procedures with Moderate Risk of Bleeding

Vascular: Arterial intervention with access size up to 7 F, Venous interventions, Chemoembolization, Uterine fibroid embolization, Transjugular liver biopsy, Tunneled central venous catheter, Subcutaneous port device

Nonvascular: Intraabdominal, chest wall, or retroperitoneal abscess drainage or biopsy, Lung biopsy, Transabdominal liver biopsy (core needle), Percutaneous cholecystostomy, Gastrostomy tube placement, Radiofrequency ablation (straightforward),

Spine procedures (vertebroplasty, kyphoplasty, lumbar puncture, facet block)

Category 3: Procedures with Significant Bleeding Risk, Difficult to Detect or Control

Vascular: Transjugular intrahepatic portosystemic shunt

Nonvascular: Renal biopsy, Biliary interventions (new tract), Nephrostomy tube placement, Radiofrequency ablation: complex

Please complete all sections of the Questionnaire:

Section 1 Demographic Information

Discipline and Training Grade: _____ **Name of Acute NHS Trust:** _____

For each of the following questions, please circle Yes or No

● Are you tertiary centre for interventional radiology procedures?	Yes/No
● Are category I procedures performed within your trust?	Yes/No
● Are category II procedures performed within your trust?	Yes/No
● Are category III procedures performed within your trust?	Yes/No

Section 2: Pre-procedural haematological testing

For each of the following items please circle yes, no or N/A. If there are certain categories of procedures e.g. level 3 are not conducted in your trust/department, please circle N/A

A) Do you routinely or is it departmental policy to check for INR for the following: Please Circle either Yes, No or NA

● Category 1 procedures:	Yes/No/NA
● Category 2 procedures:	Yes/No/NA
● Category 3 procedures:	Yes/No/NA

B) Do you routinely or is it departmental policy to check for aPTT for the following: Please Circle either Yes, No or NA

● Category 1 procedures:	Yes/No/NA
● Category 2 procedures:	Yes/No/NA
● Category 3 procedures:	Yes/No/NA

C) Do you routinely or is it departmental policy to check for **platelet** count for the following: Please Circle either Yes, No or NA

- Category 1 procedures: Yes/No/NA
- Category 2 procedures: Yes/No/NA
- Category 3 procedures: Yes/No/NA

D) Do you routinely or is it departmental policy to check for **haemoglobin** levels/haematocrit for the following: Please Circle either Yes, No or NA

- Category 1 procedures: Yes/No/NA
- Category 2 procedures: Yes/No/NA
- Category 3 procedures: Yes/No/NA

Section 3: Coagulation, Platelet and Haemoglobin Cut-offs and Management

For each of the following items please provide a value (e.g. INR levels). If there are certain categories of procedures e.g. level 3 are not conducted in your trust/department, or for which there is no local policy for, please circle N/A

A) Is there an INR level over which interventional procedures are not performed (e.g. INR >2.0) and/or require coagulation reversal

- INR level for Category 1 procedures: _____/NA
- INR level for Category 2 procedures: _____/NA
- INR level for Category 3 procedures: _____/NA

B) Is there an aPTTR level over which interventional procedures are not performed (e.g. aPTTR >2.0) and/or require coagulation reversal. (Please state units)

- aPTTR level for Category 1 procedures: _____/NA
- aPTTR level for Category 2 procedures: _____/NA
- aPTTR level for Category 3 procedures: _____/NA

C) Is there a **platelet** level under which interventional procedures are not performed (e.g. platelet < 50,000uL) and/or require platelet transfusion prior to procedures. (Please state units)

- Platelet level for Category 1 procedures: _____/NA
- Platelet level for Category 2 procedures: _____/NA
- Platelet level for Category 3 procedures: _____/NA

D) Is there a **haemoglobin** level under which interventional procedures are not performed (e.g. haemoglobin < 8 g/dL) and/or require blood transfusion prior to procedures. (Please state units)

- Haemoglobin level for Category 1 procedures: _____/NA
- Haemoglobin level for Category 2 procedures: _____/NA
- Haemoglobin level for Category 3 procedures: _____/NA

Section 4: Anticoagulant Management

For each of the following items please circle yes, no or N/A. If there are certain categories of procedures e.g. level 3 are not conducted in your trust/department, or for which there is no local policy for, please circle N/A

A) For each of the following categories of procedures, do you stop Aspirin prior to the procedure

- Category 1 procedures: Yes/No/NA
- Category 2 procedures: Yes/No/NA
- Category 3 procedures: Yes/No/NA

B) For each of the following categories of procedures, do you stop Clopidogrel prior to the procedure

- Category 1 procedures: Yes/No/NA
- Category 2 procedures: Yes/No/NA
- Category 3 procedures: Yes/No/NA

C) For each of the following categories of procedures, do you stop **Low Molecular Weight Heparin (Therapeutic Dose)** prior to the procedure

● Category 1 procedures:	Yes/No/NA
● Category 2 procedures:	Yes/No/NA
● Category 3 procedures:	Yes/No/NA

Thank you for completing this questionnaire

We would be grateful if you could provide your contact details (email and/or telephone) if you are willing to be contacted by the research team for the purpose of this study