

# Fresh frozen plasma audit report

2024

OFFICIAL



Blood Matters

OFFICIAL



# Fresh frozen plasma audit report

2024

To receive this document in another format, phone [03 9694 0102](tel:0396940102), using the National Relay Service 13 36 77 if required, or [email Blood Matters](mailto:email.Blood.Matters@redcrossblood.org.au) <[email.Blood.Matters@redcrossblood.org.au](mailto:email.Blood.Matters@redcrossblood.org.au)>.

Authorised and published by the Victorian Government, 1 Treasury Place, Melbourne.

© State of Victoria, Australia, Department of Health, [April 2024](#).

ISBN/ISSN [978-1-76131-526-8](#) (online/PDF/Word) or (print)

Available at [Blood Matters](#) Program <<https://www.health.vic.gov.au/patient-care/blood-matters-program>>

# Contents

**Acknowledgement.....6**

**Limitations .....6**

**Abbreviations and acronyms .....7**

**Executive summary.....8**

**Recommendations .....9**

**Introduction.....10**

    Appropriate use of fresh frozen plasma (FFP) .....10

**Aims and objectives.....12**

**Method .....13**

**Results and discussion .....14**

    Prescribed to reverse warfarin.....14

    Prescribed as part of therapeutic plasma exchange (TPE).....16

    Prescribed as part of massive haemorrhage protocol (MHP) .....18

    Prescribed due to bleeding .....19

    Prescribed prior to surgery .....21

    Prescribed prior to interventional radiology .....22

    Prescribed for ‘procedure’ .....23

    Prescribed for patients with chronic liver disease .....24

    Prescribed due to coagulopathy .....25

    Prescribed for treatment of disseminated intravascular coagulation (DIC).....27

**Alignment by prescriber .....28**

**Adverse events .....29**

**Conclusion .....30**

**Next steps .....32**

**References .....33**

## Acknowledgement

Blood Matters acknowledges the contribution of Australian Red Cross Lifeblood Transfusion Policy and Education (Lifeblood TPE) unit and the National Blood Transfusion Committee (NBTC). We thank them for the opportunity to collaborate on this audit. In particular, Dr Lisa Clarke, Haematologist and Transfusion Medicine Specialist (Lifeblood TPE) and member of NBTC, assisted with developing the audit and analysing transfusion episodes for alignment to the guidelines.

Blood Matters thanks everyone who contributed to this audit on fresh frozen plasma (FFP) transfusion. The efforts to collect and report data are greatly appreciated.

## Limitations

Auditors were not formally instructed nor trained for consistent data collection. Accuracy of data depends on auditors following the audit tool instructions provided by Blood Matters.

Patient selection was at the auditor's discretion, and this may have influenced the clinical speciality audited.

To minimise burden on health services, the audit tool was kept concise. This may have limited clinical information obtained in certain clinical situations. These instances are noted in the report.

The audit questions did not ask about the influence of viscoelastic testing (VET) results on the decision to transfuse FFP.

This audit was retrospective. The auditor and reviewers were not privy to individual clinical assessment and decision-making processes at the patient bedside. They could only provide and review information as documented. The report highlights instances where insufficient clinical information was obtained.

## Abbreviations and acronyms

Term	Definition
ANZSBT	Australian and New Zealand Society of Blood Transfusion
APTT	activated partial thromboplastin time
DIC	disseminated intravascular coagulation
DOAC	direct oral anticoagulants
FFP	fresh frozen plasma
FNHTR	febrile non-haemolytic transfusion reaction
GI	gastrointestinal
INR	international normalised ratio
Lifeblood	Australian Red Cross Lifeblood
Lifeblood TPE	Australian Red Cross Lifeblood Transfusion Policy and Education Unit
MHP	massive haemorrhage protocol
NBA	National Blood Authority
NBTC	National Blood Transfusion Committee
NH&MRC	National Health and Medical Research Council
PBM	patient blood management
PCC	prothrombin complex concentrate
PLT	platelet
PT	prothrombin time
PTX	Prothrombinex VF
RACP	Royal Australasian College of Physicians
ROTEM®	rotational thromboelastometry
TEG®	thromboelastography
TPE	therapeutic plasma exchange
TTP	thrombotic thrombocytopenic purpura
VET	viscoelastic testing.  The two commercially available systems in Australia are the TEG® (Haemometics® Corporation) and ROTEM® (Werfen) analysers.

## Executive summary

This audit was undertaken in collaboration with Lifeblood Transfusion Policy and Education unit (Lifeblood TPE), the NBTC and Blood Matters. It aimed to assess whether FFP use is in accordance with current guidelines for adult patients in Australia.

Thanks to Dr Lisa Clarke (Lifeblood TPE and NBTC) and Ms Trish Roberts (Lifeblood TPE) for their extensive input to the development of the audit with the Blood Matters team. Thank you to all the health services that contributed data. Special thanks to Dr Clarke for undertaking the analysis for alignment to the guidelines of the large data set.

The data is reported in sections that address the appropriate use of FFP across all major clinical indications. It highlights widespread gaps in practice in relation to the guidelines. In particular, this includes practice around warfarin reversal, where the guidance is clear.

The recommendations outline actions to help address the gaps and improve practice and appropriateness of FFP use.

The audit covers a total of 2,038 units of FFP used in 892 transfusion episodes, with 850 units (42 per cent) used in episodes in ways that were non-aligned to the guidelines.

Blood Matters will disseminate the findings of the audit to health services, interested parties and relevant colleges to highlight the gaps to help improve knowledge and understanding among prescribing groups.

Blood Matters recommends that health services review the report and their individual and comparative data. Health services should work with their local blood management/transfusion committee to address gaps in practice to guidelines.



## Recommendations

Recommendation	Audit alignment	Responsibility
Assess policy and practice alignment to guidelines for reversal of warfarin.	46%	Health services
Revise knowledge of the consensus guidelines for warfarin reversal (Tran et al., 2013). Note that there are updated guidelines in progress, as the current prothrombin complex concentrates will be transitioning to new products in late 2024 and 2025.	46%	Health services and clinicians
Review policies and procedures regarding the use of fluid replacement in plasma exchange to ensure they follow best practice.	21%	Health services
Review massive haemorrhage protocols to ensure they are aligned to the NBA Patient Blood Management guideline for adults with critical bleeding 2023 (published after the audit).	100%	Health services
Review the role of transfusion scientists, with support from haematologists, where required, to assess appropriateness of FFP requests. Introduce procedures for actions to be taken where requests do not adhere to guidelines, if not already in place.	NA	Health services / pathology providers
Provide individual reports and report summary to health services, both those that participated and other health services to highlight the areas of practice that may require review.	NA	Blood Matters
Blood Matters will engage stakeholders to disseminate the findings of the audit to improve knowledge and understanding among prescribing groups through their relevant colleges.	NA	Blood Matters
All blood and blood products must be traceable for 20 years following administration. It was noted in the audit that in some instances, the auditor was uncertain if products (for example, Prothrombinex VF) had been administered.  Review procedures for documenting blood products administered to meet standards.	NA	Health services / pathology providers

## Introduction

The Blood Matters Program works with health services to ensure that blood components and products are used appropriately and safely.

Blood Matters conducted FFP audits in 2005 and 2008. The audits found that 34 and 32 per cent of FFP transfusion episodes respectively were not aligned to the National Health and Medical Research Council (NH&MRC) clinical guidelines (now rescinded).

Finding poor alignment to the FFP guidelines is a common problem across Australia and internationally.

A New South Wales study (Schofield et al. 2003) involving 14 hospitals (including tertiary referral, major metropolitan and major rural hospitals) found that 37 per cent of FFP transfusions were potentially inappropriate, with no difference between hospital types. Similarly, Royal Darwin Hospital found that 29 per cent of FFP requests were either based on inadequate clinical or laboratory data or were clearly not indicated based on the national clinical guidelines (Moylan 2008).

Since these audits, the national guidelines have been updated with the publication of the National Blood Authority (NBA) patient blood management guidelines, which comprise a series of six modules released between 2011 and 2016. These modules are currently under review, but the original modules remain in place to guide practice.

In addition, the Australian and New Zealand Society of Blood Transfusion (ANZSBT), in combination with the Royal Australasian College of Physicians (RACP), has released recommendations to reduce low-value practices including the transfusion of FFP to correct mildly elevated international normalised ratio (INR) prior to a procedure (RACP Evolve and ANZSBT 2022).

There has also been an update of consensus guidelines for warfarin reversal (Tran et al. 2013).

This audit has been developed in conjunction with Lifeblood TPE, the NBTC and Blood Matters.

The aim is to assess whether FFP use is in accordance with current guidelines regarding adult patients across health services in Australia.

## Appropriate use of fresh frozen plasma (FFP)

- FFP is used for patients with a coagulopathy (as detected by abnormal laboratory tests such as INR or prothrombin time (PT)) who are bleeding or at risk of bleeding, and where a specific therapy or factor concentrate is not appropriate or is unavailable (Lifeblood 2024).
- The prophylactic use of FFP for medical patients with a coagulopathy is not supported in current patient blood management (PBM) guidelines.
- Recent Evolve recommendations state FFP may be considered at an INR threshold > 1.8 in the periprocedural period. Consider using higher thresholds for patients with end-stage liver disease, where there is balanced haemostasis, as conventional coagulation studies correlate poorly with bleeding risk.
- Therapeutic plasma exchange (TPE) with FFP is an accepted treatment for patients with thrombotic thrombocytopenic purpura (TTP) (Lifeblood 2024).
- FFP use in massive haemorrhage or massive transfusion is an accepted treatment.
- It is appropriate to use FFP in cases of warfarin overdose with life-threatening bleeding in addition to prothrombin complex concentrates (PCC), for example, Prothrombinex-VF and

vitamin K. Where PCCs are not available, FFP is suggested in patients with life-threatening or clinically significant bleeding, and for urgent preoperative warfarin reversal (Tran et.al. 2013).

FFP is not routinely indicated in the following circumstances (Lifeblood 2024):

- when coagulopathy can be corrected effectively with specific therapy, such as vitamin K, cryoprecipitate, factor VIII or other specific factor concentrates
- in TPE procedures except for treatment in TTP
- treatment of immunodeficiency states.

## Aims and objectives

The aims of the 2023 audit were to:

- gain further understanding of FFP use in adult patients across health services
- assess whether use is in accordance with current guidelines.

The objectives of the audit were to:

- assess the use of FFP in Australian hospitals against current guidelines for [warfarin reversal](#),<sup>1</sup> [NBA PBM modules](#)<sup>2</sup> and [Evolve 5](#)<sup>3</sup>
- provide health services with a snapshot of FFP use in their organisation and identify opportunities to improve patient blood management
- benchmark practice between health services
- inform the NBTC of practice gaps and opportunities for improved practice.

---

<sup>1</sup> <<https://blood.gov.au/update-consensus-guidelines-warfarin-reversal>>

<sup>2</sup> <<https://blood.gov.au/pbm-guidelines>>

<sup>3</sup> <[https://anzsbt.org.au/wp-content/uploads/2022/03/FINAL-evolve\\_top-five\\_anzsbt.pdf](https://anzsbt.org.au/wp-content/uploads/2022/03/FINAL-evolve_top-five_anzsbt.pdf)>

## Method

This is the first time Blood Matters, Lifeblood TPE and the NBTC have collaborated to conduct a national audit using the Lifeblood Audit Tool.

The audit was open to all health services. It was promoted by Lifeblood TPE in their newsletter *Transfused*, which has 7,100 subscribers, as well as via their Twitter (now X) account.

Emails were also sent to existing networks.

In addition, the NBTC circulated information about the audit through their networks. Blood Matters separately notified 140 health services in Victoria, Tasmania, the Northern Territory and the Australian Capital Territory that the audit was being conducted and invited public and private health services to participate.

This was a retrospective audit of the medical records of up to 30 FFP transfusion episodes (or all transfusion episodes if less than 30) that occurred between 1 April 2022 and 31 March 2023 in adult patients ( $\geq 18$  years).

Data collection was open between 1 April to 30 June 2023.

It was expected that the health service blood management/transfusion committee or equivalent would designate the staff to collect and enter data.

The auditors were not trained. However, Blood Matters and Lifeblood TPE staff were available to provide guidance and clarification.

All auditors entered data electronically through the Lifeblood Audit Tool. Health services in the four jurisdictions contributing data to Blood Matters also exported their completed data to a CSV file and emailed it to Blood Matters. This allowed the original dataset to remain deidentified regarding health service and patient identity. Blood Matters then imported the data into a customised Microsoft Access database to analyse.

The Lifeblood Audit Tool allows health services to generate a summary report of their own data. It also allows them to correct their own data. Any data added or corrected in the Lifeblood Audit Tool after the end date for data collection was not included in the audit.

Dr Clarke, Haematologist and Transfusion Medicine Specialist at Lifeblood, analysed all submitted transfusion episodes to assign alignment to the guidelines. This work was shared with Blood Matters.

If a health service had no FFP transfusions during the reporting period and would normally submit data to Blood Matters, it was asked to notify the audit team.

## Results and discussion

Overall, 935 FFP transfusion episodes were submitted to the Lifeblood Audit Tool.

Forty-three transfusion episodes were excluded from the analysis because there was not enough information provided to determine an indication for transfusion.

Indication for a transfusion was primarily assigned using the auditor-submitted event classification.

An assessment of alignment to the guidelines was based on the guidelines current at the time of the audit and information provided by the auditors. A transfusion episode may have been assessed as non-aligned due to a lack of information, although in practice some of these episodes may have been in alignment.

Inadequate information may have been due to lack of documentation in the medical record, poor auditing, or the dataset requested.

This report examined 892 transfusion episodes (audits) (Table 1).

**Table 1: Primary indication for prescription of FFP as provided by auditor**

Indication	Number of FFP transfusion episodes n (%)
Warfarin reversal	57 (6)
TPE	52 (6)
MHP	344 (39)
Other (bleeding)	141 (16)
Prior to surgery	90 (10)
Prior to interventional radiology	32 (4)
Other (procedure)	69 (8)
Chronic liver disease	47 (5)
Other (coagulopathy)	39 (4)
DIC	21 (2)
<b>Total</b>	<b>892</b>

### Prescribed to reverse warfarin

For immediate warfarin reversal, PCC are preferred over FFP. At the time of this report being published, Prothrombinex-VF was the only PCC available for warfarin reversal in Australia.

FFP should not be used routinely to reverse warfarin anticoagulation. However, where PCC is unavailable or, in addition to Prothrombinex-VF in life-threatening bleeding, where emergency reversal is required, FFP should be used, along with vitamin K<sub>1</sub> to sustain the reversal effect (Tran et al. 2013).

Surgery can be conducted with minimal increased risk of bleeding if INR ≤ 1.5. For minor procedures where bleeding risk is low, warfarin may not need to be interrupted. If necessary, warfarin can be withheld for five days before elective surgery, or intravenous vitamin K<sub>1</sub> can be given the night before surgery. Prothrombinex-VF use for warfarin reversal pre-surgery, should be restricted to emergency settings (Tran et al. 2013).

Fifty-seven transfusions were reported as prescribed for warfarin reversal. Of these, 41 were from 18 health services in response to the Blood Matters invitation to participate.

As might be expected, most patients in this group were older than 60 years (84 per cent, n = 48).

Forty-six per cent (n = 26) of the audits aligned to current guidelines for use in warfarin reversal, The remaining 31 (54 per cent) were non-aligned.

Table 2 includes further details of aligned FFP use. The majority of aligned FFP episodes occurred in patients with life-threatening bleeding (23 of 26, 88 per cent).

**Table 2: Aligned use of FFP for management of patients on warfarin therapy (n=26)**

Category	Number of FFP transfusion episodes n (%)	Total FFP units transfused	INR range	INR average
INR > or equal 1.5 with life-threatening (critical organ) bleeding	23 (88)	40	1.6–10	3.7
INR > or equal 2.0 with clinically significant bleeding (not life-threatening) and NO PCC (PTX) available	2 (8)	2	2.1–5	3.6
INR > 1.5 and urgent surgery NO PCC available	1 (4)	4	2.4	2.4

Note that Prothrombinex-VF is contraindicated for patients with disseminated intravascular coagulation (DIC), as it may potentiate existing thrombotic tendency, which is a feature of patients with DIC. Therefore, using FFP alone (or with Vitamin K<sub>1</sub>) for warfarin reversal may be appropriate for some patients.

Non-aligned episodes (Table 3) most often occurred in patients who required urgent surgery with INR > 1.5, where guidelines recommend Prothrombinex-VF is used (Tran et al. 2013). The audit found that in 13 of 31 episodes (43 per cent), Prothrombinex-VF was available but not used or, if used, FFP was given unnecessarily.

**Table 3: Non-aligned use of FFP for management of patients on warfarin therapy (n = 31)**

Category	Number of FFP transfusion episodes n (%)	Total FFP units transfused	INR range	INR average
INR < 1.5 and invasive procedure	4 (13)	13	1.2–1.5	1.3
INR > 1.5 and urgent surgery PTX available and not used or used in conjunction with FFP	13 (43)	23	1.6–8.9	2.9
INR < 2 with clinically significant bleeding <sup>4</sup>	2 (7)	4	0.9–1.2	1.1
INR > 2 and clinically significant bleeding PTX available and not used or used in conjunction with FFP	7 (23)	11	2.8–10	4.5
No bleeding, INR <10	2 (7)	3	3.1–5.3	4.2
Unknown	3 (7)	9	-	-

Most patients had a form of coagulation testing performed pre-transfusion (Table 4). The majority had an INR performed, with two patients also having viscoelastic testing (VET). In two cases it was unclear if testing had occurred.

**Table 4: Type of coagulation testing performed pre-transfusion<sup>5</sup>**

Transfusion aligned to guidelines	Viscoelastic testing (ROTEM/TEG) n (%)	INR n (%)	No testing n (%)	Unknown n (%)
Yes (n = 26)	1 (4)	25 (96)	-	-
No (n = 31)	1 (3)	29 (93)	-	2 (6)

Overall, FFP used for warfarin reversal was aligned to the guidelines in 46 per cent of audits. Where its use was non-aligned, this was often due to FFP being used in conjunction with PCC, without associated bleeding, or FFP alone was transfused when PCC (PTX) was available and suitable for use.

## Prescribed as part of therapeutic plasma exchange (TPE)

Fifty-two transfusions were reported as prescribed as part of TPE. Of these, 41 were from 13 health services invited to participate by Blood Matters.

<sup>4</sup> Patients did not receive PTX although it was available.

<sup>5</sup> Multiple testing types could be selected.



**Table 5: FFP prescribed as part of TPE**

Indication for TPE	Number of FFP transfusion episodes n (%)	Total FFP units transfused	Deemed aligned to guidelines n (%)
Immune/rheumatology condition	14 (27)	62	0 (0)
Neurological condition	4 (8)	19	0 (0)
Pre or post organ transplant	13 (25)	61	0 (0)
Thrombotic thrombocytopenic purpura (TTP)	11 (21)	43	11 (100)
Other	10 (19)	44	0 (0)
<b>Total</b>	<b>52</b>	<b>229</b>	<b>11 (21)</b>

Of the 229 units of FFP transfused to patients in this audit group, 186 (81 per cent) were transfused in episodes deemed non-aligned.

Plasma exchange with FFP is an accepted treatment, to replace deficient ADAMTS13, for patients TTP. All transfusions of FFP for patients with TTP were aligned to the guidelines (Table 5).

Use of FFP in TPE for indications other than TTP are less clear. Typically, an albumin solution is used as the main replacement fluid. Routine use of FFP for TPE is not generally required.

If the patient has daily exchanges, FFP might be required if significant changes in coagulation status occur, or to prevent dilutional coagulopathy. FFP might also be required for patients who will undergo surgical or other interventional procedure in the 24 hours following TPE. This is particularly the case if they have undergone multiple TPE procedures in a short timeframe.

Where FFP is required, partial transfusion of FFP (2–4 units) given in the last part of the procedure is adequate to replace missing coagulation factors with albumin for the remainder of the volume replacement.

Unfortunately, the audit did not capture the aligned need for FFP with TPE beyond the clinical indication of TTP. Although the episodes were deemed non-aligned, this is not a definitive determination because further information was not available to confirm the use of FFP was indicated.

Health services should assess their policies and procedures regarding fluid replacement in TPE to ensure they follow best practice.

Pre-transfusion coagulation testing (Table 6) was reported as performed in most episodes. However, 11 patients (21 per cent) had no pre-transfusion coagulation testing available. The majority of these (n = 10) were non-aligned transfusion episodes. In patients where FFP is indicated to treat a coagulation deficiency or pre-procedure, testing should determine transfusion need.

**Table 6: Type of pre-transfusion coagulation testing<sup>6</sup>**

Transfusion aligned to guidelines	Viscoelastic testing (RoTEM/TEG) n (%)	INR n (%)	No testing n (%)	Unknown n (%)
Yes (n = 11)	-	9 (82)	1 (9)	1 (9)
No (n = 41)	1 (2)	26 (63)	10 (24)	5 (12)

Overall, alignment was deemed appropriate for all patients being treated for TTP (21 per cent), as this would be routine practice to use FFP replacement. For other patient groups the indication for FFP is less clear due to insufficient information. For those patients without pre-transfusion coagulation testing, the indication for FFP use is unclear. There is no evidence replacement of coagulation factors is needed, although with further information this may be valid.

## Prescribed as part of massive haemorrhage protocol (MHP)

344 transfusions were reported as prescribed as part of a massive haemorrhage protocol (MHP). Of these, 258 were from 36 health services invited to participate by Blood Matters.

Table 7 outlines the bleeding scenario that resulted in activation of the MHP. The most frequent reason was surgical bleeding (not trauma related) (n = 126, 37 per cent), followed by gastrointestinal (GI) bleeds 35 per cent (n = 122).

**Table 7: FFP prescribed as part of MHP**

MHP triggered by	Number of FFP transfusion episodes n (%)	Total FFP units transfused	Deemed aligned to guidelines (%)
Surgical bleed (not related to trauma)	126 (37)	351	100
GI bleed	122 (35)	276	100
Obstetric bleed	35 (10)	85	100
Trauma	33 (10)	83	100
Other	28 (8)	71	100

All reported FFP use related to MHP was deemed aligned. The current guidelines state:

In patients with critical bleeding managed with a ratio-based major haemorrhage protocol, a high ratio of RBC:FFP:PLT may be beneficial, although there is insufficient evidence to support a 1:1:1 ratio over a 2:1:1 ratio (NBA, 2022, Table 8).

To maintain these ratios, early treatment with FFP is required.

Although these episodes were reported as MHPs, not all resulted in large volumes of blood being administered (Table 9). However, at the time of transfusion clinical staff considered the bleeding to be critical with the potential for massive transfusion. It is recommended to activate an MHP early for best outcomes and to allow communication with the laboratory and other necessary groups.

<sup>6</sup> Multiple testing types could be selected.

**Table 8: RBC:FFP:PLT ratio according to NBA 'Management of adults with critical bleeding' guidelines**

Ratio	RBC (n)	FFP (n)	Platelets (n) <sup>7</sup>
1:1:1	4	4	1
2:1:1	8	4	1

The ratio of FFP to RBC was better aligned to guidelines when fewer numbers of RBC were transfused in an MHP. As the number of RBC transfused increased, the ratio of FFP decreased. The FFP dosage does not appear to meet the ratios as outlined in the guidelines in many cases.

It is recommended that health services review their MHP template to ensure the target ratio of RBC:FFP is stipulated, and review practices to align to the current guideline for management of critical bleeding in adults (NBA 2023).

**Table 9: RBC:FFP ratio in MHP transfusion episodes reported**

RBC dose (units)	Number of transfusion episodes (n) <sup>8*</sup>	Average RBC (range)	Average FFP (range)	Average RBC:FFP ratio
< 5 units	141	3.3 (1–4)	2.2 (1–5)	3:2
5 or greater	202	7.9 (5–24)	2.8 (1–5)	3:1

Pre-transfusion coagulation testing (Table 10) was reported as performed in most episodes. Not unexpectedly, a small number of patients did not have testing performed prior to the administration of FFP. When patients are critically bleeding, the decision to transfuse FFP to maintain ratios may occur before testing or before results are available. Even when a patient is not currently coagulopathic, administration of FFP as guided by transfusion ratios is important to prevent dilutional coagulopathy developing in an MHP.

**Table 10: Type of pre-transfusion coagulation testing<sup>9</sup>**

Transfusion aligned to guidelines	Viscoelastic testing (ROTEM/TEG) n (%)	INR n (%)	No testing n (%)	Unknown n (%)
Yes (n = 344)	71 (21)	288 (84%)	23 (7)	19 (6)

## Prescribed due to bleeding

141 transfusions were reported as prescribed for bleeding. Of these, 110 were from 26 health services registered with Blood Matters.

Allocation to this category was based primarily on the diagnosis at admission and the open-ended response on indication, where the auditor-submitted indication for FFP transfusion as 'unknown'.

<sup>7</sup> One adult unit of apheresis or pooled platelets in Australia is equivalent to platelets derived from the buffy coats from four single whole blood donor units.

<sup>8</sup> One did not report RBC dose.

<sup>9</sup> Multiple testing types could be selected.

Most often, FFP was prescribed for patients with bleeding associated with a surgical procedure, either intraoperative (n = 49) or post-operative (n = 34), with better alignment in the post-operative period (Table 11). These patients were not identified as requiring an MHP. However, they had bleeding that may have caused clinicians to consider and administer FFP early.

**Table 11: FFP prescribed for bleeding**

Bleeding event	Number of FFP transfusion episodes n	Deemed aligned to guidelines <sup>10</sup> n (%)	Total FFP units transfused – aligned	Deemed non-aligned to guidelines n (%)	Total FFP units transfused – non-aligned
Intraoperative bleeding/oozing	49	7 (14)	11	37 (76)	92
Post-operative bleed	34	20 (59)	35	13 (38)	21
Gastrointestinal bleed	25	10 (40)	22	12 (48)	21
Gynaecology/obstetrics	4	0 (0)	-	3 (75)	5
Intracranial	4	2 (50)	3	2 (50)	4
Epistaxis	4	3 (75)	4	1 (25)	2
Trauma	3	0 (0)	-	3 (100)	4
Other	18	6 (33)	12	11 (61)	16
<b>Total</b>	<b>141</b>	<b>48 (34)</b>	<b>87</b>	<b>82 (58)</b>	<b>165</b>

The 82 transfusion episodes deemed non-aligned to guidelines all had an INR < 1.5, hence FFP is not indicated.

FFP may be indicated in bleeding patients who require replacement of labile plasma coagulation factors such as in massive haemorrhage/ transfusion, cardiac bypass, liver disease or acute DIC (Lifeblood 2024).

Most patients had a form of coagulation testing performed prior to transfusion of FFP (Table 12).

**Table 12: Types of pre-transfusion coagulation testing (n = 141)<sup>11</sup>**

Transfusion aligned to guidelines	Viscoelastic testing (ROTEM/TEG) n (%)	INR n (%)	No testing n (%)	Unknown n (%)
Yes (n = 48)	3 (6)	47 (98)	-	-
No (n = 82)	4 (5)	79 (96)	3 (4)	-
Not assessable (n = 11)	-	-	8 (73)	3 (27)

<sup>10</sup> Eleven were not assessable due to insufficient information.

<sup>11</sup> Multiple testing types could be selected.

## Prescribed prior to surgery

Ninety transfusions were reported as prescribed prior to surgery. Of these, 82 were from 20 health services invited to participate by Blood Matters.

In 2009, an audit across the United Kingdom demonstrated that 43 per cent of FFP transfusions in adults were administered to patients with no documented bleeding, as prophylaxis before interventions because of abnormal coagulation tests. There is no evidence validating FFP use in these settings. This practice potentially exposes patients to unnecessary transfusion. More importantly, transfusion of FFP only resulted in minimal, or no correction of PT or INR (Green et al. 2018).

A US study of more than 6,000 FFP transfusions found 20 per cent occurred pre-procedure, 29 per cent intraoperatively and 30 per cent postoperatively. The majority were administered to people with a mildly elevated INR (Warner et al. 2018). This study also found that people with the highest INRs had the best responses to FFP infusions, but that only 17 per cent of transfusions resulted in normalisation of INR.

Of the 90 transfusion episodes reported as prior to surgery, 31 (34 per cent) were deemed aligned to the Evolve recommendations. Table 13 shows categories of alignment.

**Table 13: FFP prescribed prior to surgery<sup>12</sup>**

Category	Number of FFP transfusion episodes n (%)	Total FFP units transfused	Deemed aligned to guidelines n (%)
INR < 1.5	25	58	0 (0)
INR 1.5–1.7 (with or without chronic liver disease)	20	32	0 (0)
INR 1.8–2.5 with liver disease	7	11	0 (0)
INR ≥ 1.8 (with no liver disease)	29	65	29 (100)
INR ≥ 2.5 with liver disease	2	4	2 (100)
Not assessable	7	17	-

Clarity of the guidance regarding FFP use prior to surgery has improved with the introduction of the Evolve recommendations in March 2022. Twenty-five episodes that were considered non-aligned in this audit may have previously been considered aligned due to less clearly defined recommendations.

This includes 18 episodes with an INR 1.5–1.7 (with no chronic liver disease) category and seven transfusions with INR 1.8–2.5 (with chronic liver disease) category. These transfusions occurred throughout the full reporting period.

<sup>12</sup> The Evolve recommendations do not explicitly cover patients with chronic liver disease (including prior to surgery). Alignment was determined by the expert reviewer.

Most patients had a form of coagulation testing performed prior to transfusion of FFP (Table 14). However, 25 patients had an INR of < 1.5 and where posttransfusion coagulation testing results were available, there was no significant change in the INR.

**Table 12: Types of pre-transfusion coagulation testing (n = 90)<sup>13</sup>**

Transfusion aligned to guidelines	Viscoelastic testing (ROTEM/TEG) n (%)	INR n (%)	No testing n (%)	Unknown n (%)
Yes (n = 31)	2 (6)	31 (100)	-	-
No (n = 52)	2 (4)	49 (94)	-	2
Not assessable (n = 7)		1 (14)	4 (57)	2 (29)

## Prescribed prior to interventional radiology

Thirty-two transfusions were reported as prescribed prior to interventional radiology. Of these, 30 were from 12 health services invited to participate by Blood Matters.

The Evolve recommendations state:

do not transfuse standard doses of fresh frozen plasma to correct a mildly elevated (<1.8) INR prior to a procedure. The evidence supports the use of Vitamin K1 and suggests the use of FFP correlated with an increased risk of intra-operative bleeding and/or increased risk of transfusion reactions.

Of the 32 transfusion episodes reported only seven (22 per cent) were deemed to align to the current Evolve recommendations. Table 15 shows categories of alignment for FFP use prior to interventional radiology.

The guidelines for the use of FFP in this patient group were less clearly defined prior to the introduction of the Evolve recommendations in March 2022. Therefore, five episodes that may have been considered aligned prior to Evolve, were deemed non-aligned to the Evolve recommendation.

**Table 13: Aligned use of FFP for management of patients prior to interventional radiology**

Category	Number of FFP transfusion episodes n (%)	Total FFP units transfused	INR range	INR average
INR 1.5–1.7 and bleeding	1 (14)	2	1.5	1.5
INR ≥ 1.8	5 (71)	7	1.8–4.6	2.4
INR ≥ 2.5 and liver disease	1 (14)	2	2.5	2.5

<sup>13</sup> Multiple testing types could be selected.

Twenty-five (78 per cent) of FFP transfusion episodes were considered non-aligned to current guidelines (Table 16). Of these, five within the INR < 1.5 category may have been considered aligned prior to Evolve. These transfusions occurred between May 2022 and March 2023.

**Table 14: Non-aligned use of FFP for management of patients prior to interventional radiology**

Category	Number of FFP transfusion episodes n (%)	Total FFP units transfused	INR range	INR average
INR < 1.5 (with or without bleeding)	8 (32)	11	0.9–1.4	1.25
INR 1.5– 1.7 (without bleeding / with liver disease)	9 (36)	16	1.5–1.7	1.59
INR 1.8–2.5 and liver disease	8 (32)	19	1.8–2.3	2.0

Patients with chronic liver disease are deemed non-aligned due to their ability to maintain a balanced haemostasis. These patients have a relative deficiency of both procoagulant and anticoagulant factors. The balance between these is more fragile and more easily tipped toward bleeding or thrombosis than in other patient groups. The use of FFP to prevent bleeding is therefore not supported, unless other reasons dictate. In this group, the audit provided limited data on what these other factors might be.

Pretransfusion coagulation testing (Table 17) was reported as performed in all episodes.

**Table 15: Type of pre-transfusion coagulation testing**

Transfusion aligned to guidelines	Viscoelastic testing (ROTEM/TEG) n (%)	INR n (%)	No testing n (%)	Unknown n (%)
Yes (n = 7)	-	7 (100)	-	-
No (n = 25)	-	25 (100)	-	-

## Prescribed for ‘procedure’

Sixty-nine transfusions were reported as prescribed for some type of procedure. Of these, 41 were from 15 health services invited to participate by Blood Matters.

Allocation to this category was based primarily on the diagnosis at admission, and the open-ended response regarding indication, since the auditor-submitted indication for FFP transfusion as ‘unknown’.

Of the 69 transfusion episodes reported, 8 (12 per cent) were deemed aligned to the guidelines. Table 18 shows categories of alignment. Clarity of guidance for appropriate FFP use has improved with the introduction of the Evolve recommendations in March 2022. These stated not to transfuse standard doses of FFP to correct a mildly elevated (< 1.8) INR prior to a procedure (Evolve). There were 17 episodes considered non-aligned; however, prior to the Evolve recommendation they may have been considered aligned.

**Table 18: FFP prescribed for procedure and INR results**

INR	Number of FFP transfusion episodes n (%)	Total FFP units transfused	Deemed aligned to guidelines n (%)	Deemed non-aligned to guidelines
< 1.5	39	84	0 (0)	39 (100)
1.5–1.8	17	31	0 (0)	17 (100)
> 1.8	8	21	8 (100)	-
Not available	5	10	-	5 <sup>14</sup>

Most patients had a form of coagulation testing performed prior to transfusion of FFP (Table 19).

**Table 19: Types of pre-transfusion coagulation testing (n = 69)<sup>15</sup>**

Transfusion aligned to guidelines	Viscoelastic testing (ROTEM/TEG) n (%)	INR n (%)	No testing n (%)	Unknown n (%)
Yes (n = 8)	1 (12)	7 (88)	-	-
No (n = 56)	7 (12)	50 (89)	-	4 (7)
Not assessable (n = 5)	-	1 (20)	2 (40)	2 (40)

The audit questions did not ask about the influence of VET results on the decision to transfuse FFP. VET provides an overall indication of in vivo clot strength and fibrinolysis. Where VET was performed, it is acknowledged the associated algorithm could have indicated FFP was required despite the INR being < 1.8.

## Prescribed for patients with chronic liver disease

Forty-seven transfusions were reported as prescribed or indicated for patients with chronic liver disease. Of these, 42 were from 17 health services invited to participate by Blood Matters.

In the audit assessment, liver disease included those patients with chronic types of liver disease, not acute causes of liver disease or dysfunction.

Fourteen (30 per cent) transfusions were assessed as aligned to guidelines, using 26 units of FFP (Table 20). The routine use of FFP for low-risk procedures is not recommended in these patients unless other risk factors are present.

<sup>14</sup> Not assessable without INR.

<sup>15</sup> Multiple testing types could be selected.



**Table 20: FFP prescribed for chronic liver disease**

Category	Number of FFP transfusion episodes <sup>16</sup> n (%)	Total FFP units transfused	Deemed aligned to guidelines n (%)
INR < 1.5 (with or without bleeding/procedure)	6 (13)	15	0 (0)
INR 1.5–1.7	7 (15)	14	0 (0)
INR ≥ 1.8 (no bleeding)	19 (40)	44	0 (0)
INR ≥ 1.8 with bleeding	12 (26)	23	12 (100)
Liver transplant	2 (4)	3	2 (100)

Prolongation of coagulation tests (PT, INR and APTT) is common in liver disease, which is often perceived as a sign of increased bleeding risk. However, studies have shown this is not necessarily true in patients with liver-related complications, such as variceal haemorrhage (Green et al. 2018). While some patients will have a bleeding tendency others will have a prothrombotic tendency.

As VET provides an overall indication of in vivo clot strength and fibrinolysis, it may give a better understanding of bleeding risk in this group of patients. Table 21 indicates that few patients had VET.

**Table 21: Types of pre-transfusion coagulation testing<sup>17</sup>**

Transfusion aligned to guidelines	Viscoelastic testing (ROTEM/TEG) n (%)	INR n (%)	No testing n (%)	Unknown n (%)
Yes (n = 14)	1 (7)	11 (79)	1 (7)	1 (7)
No (n = 32)	1 (3)	31 (97)	-	-
Not assessable (n = 1)	-	-	1 (100)	-

## Prescribed due to coagulopathy

Thirty-nine transfusions were reported as prescribed for treatment of coagulopathy. Of these, 22 were from 13 health services invited to participate by Blood Matters.

Allocation to this category was based primarily on admission diagnosis and open-ended responses on indication, since the auditor-submitted indication for FFP transfusion as 'other or unknown'.

Of the 39 transfusion episodes, only 7 (18 per cent) were deemed aligned to guidelines, with six transfusions considered not assessable due to insufficient information (Table 22).

<sup>16</sup> One was deemed not assessable.

<sup>17</sup> Multiple testing types could be selected.

**Table 6: FFP prescribed for coagulopathy**

Reasons for coagulopathy as indicated by auditor	Number of FFP transfusion episodes <sup>18</sup> n (%)	Total FFP units transfused	Deemed aligned to guidelines* n (%)
Used to reverse direct oral anticoagulants (DOACs)	9 (23)	16	0 (0)
High INR no bleeding	9 (23)	23	0 (0)
Normal INR	6 (15)	12	0 (0)
DIC no bleeding	2 (5)	6	0 (0)
Urgent surgery and INR > 1.8	2 (5)	5	2 (100)
Bleeding	3 (8)	2	3 (100)
Factor deficiency	2 (5)	4	2 (100)

No improvement in bleeding outcomes is seen when FFP is used to reverse DOACs. The benefit of blood-component therapies or prohaemostatic agents in the absence of coexisting coagulopathy remains unclear (Mujer 2020).

There is very little evidence to support the effectiveness of prophylactic use of FFP (in any clinical setting) to correct abnormal coagulation tests or reduce bleeding events, particularly when the INR is between 1.5–1.9 (Green et al. 2018).

FFP is indicated for patients with a coagulopathy who are bleeding or at risk of bleeding where a specific therapy such as vitamin K<sub>1</sub> or factor concentrate is not appropriate or unavailable (Blood component information, Lifeblood 2023). Risk of bleeding was not collected. The routine use of FFP in medical patients with coagulopathy (including those with liver impairment) is not supported. The routine use of FFP in critically ill patients with coagulopathy is not advised. The underlying causes of coagulopathy should be identified (NBA PBM guidelines companion 26). Table 23 outlines the types of pre-transfusion coagulation testing.

**Table 23: Types of pre-transfusion coagulation testing<sup>19</sup>**

Transfusion aligned to guidelines	Viscoelastic testing (ROTEM/TEG) n (%)	INR n (%)	No testing n (%)	Unknown n (%)
Yes (n = 7)	3 (43)	7 (57)	-	-
No (n = 28)	4 (14)	27 (96)	1 (4)	-
Not assessable (n = 4)	1 (25)	3 (75)		

<sup>18</sup> Six were not assessable.

<sup>19</sup> Multiple testing types could be selected.

## Prescribed for treatment of disseminated intravascular coagulation (DIC)

Twenty-one transfusions were reported as prescribed for patients with DIC having a procedure. Of these, 18 were from 12 health services invited to participate by Blood Matters.

Of the 21 transfusion episodes reported, three (14 per cent) were deemed aligned to guidelines. Table 24 shows the INR categories and assessed alignment. Those patients with INR < 1.5 are not deemed aligned to guidelines.

FFP plays an important role in therapeutic management in patients with DIC when overt bleeding is present or anticipated with disturbed coagulation, or when an invasive procedure is being planned.

It is not indicated in patients with chronic DIC.

The audit did not ask specific questions about bleeding or planned procedure in this group. However, some auditors provided information that indicated bleeding or procedures in some patients.

**Table 24: FFP prescribed for DIC and INR results**

INR	Number of FFP transfusion episodes n (%)	Total FFP units transfused	Deemed aligned to guidelines n (%)*	Deemed non-aligned to guidelines
< 1.5	7 (33)	13	0 (0)	7 (100)
1.5–1.8 (no bleeding/planned procedure)	4 (19)	10	0 (0)	4 (100)
1.5–1.8 (with bleeding)	1 (5)	1	1 (100)	0 (0)
> 1.8 (no bleeding/planned procedure)	7 (33)	21	0 (0)	7 (100)
> 1.8 (with bleeding/planned procedure)	2 (10)	7	2 (100)	0 (0)

All patients had a form of coagulation testing performed prior to transfusion of FFP (Table 25).

**Table 25: Types of pre-transfusion coagulation testing (n = 69)<sup>20</sup>**

Transfusion aligned to guidelines	Viscoelastic testing (ROTEM/TEG) n (%)	INR n (%)	No testing n (%)	Unknown n (%)
Yes (n = 3)	1 (33)	3 (100)	-	-
No (n = 18)	1 (6)	18 (100)	-	-

<sup>20</sup> Multiple testing types could be selected.

## Alignment by prescriber

The audit asked for the prescribers' speciality, where known. Information was provided for 863 episodes, as shown in Table 26; 29 did not respond.

**Table 26: Alignment by prescriber**

Prescriber speciality	Total	Number aligned (%)	Number non-aligned (%)
Anaesthetist	209	132 (63)	77 (37)
Emergency/trauma	115	97 (84)	18 (16)
Gastroenterologist	42	26 (62)	16 (38)
General medicine	102	40 (39)	62 (61)
Haematologist	57	21 (37)	36 (63)
Intensivist	218	119 (55)	99 (45)
Surgeon	81	46 (57)	35 (43)
Unknown	39	18 (46)	21 (54)

The transfusions most frequently aligned to guidelines occurred in the emergency/trauma group (84 per cent), possibly due in part to all MHPs being deemed aligned.

Alignment for all groups of prescribers indicates an opportunity for improvement. However, as noted previously, reviewers were not privy to individual clinical assessment and decision-making processes at the patient bedside.

## Adverse events

Transfusion of blood products are beneficial, but they can also pose risks for patients.

Adverse transfusion reactions occur when patients experience an undesirable response associated with transfusion of blood or blood products. This is why, in part, patient blood management aims to avoid unnecessary exposure to blood components.

Adverse events were reported in patients who received FFP for warfarin reversal, TPE, MHP, bleeding and prior to surgery, as seen in Table 27. Adverse events were not reported in the other FFP transfusion episode categories.

**Table 27: Adverse events associated with FFP transfusion**

Event alignment	Warfarin reversal	TPE	MHP	Bleeding	Surgery	Total
Aligned to guidelines	1 x rash	1 x anaphylactic 2 x rash	1x mild allergic 1x anaphylaxis 1x FNHTR 1x hyperkalaemia	1x mild allergic	1 x urticarial rash	<b>10</b>
Non-aligned to guidelines	1 x rash and hypoxia	2x rash	0	1x mild allergic	1 x reaction not specified	<b>5</b>
<b>Total events</b>	<b>2</b>	<b>5</b>	<b>4</b>	<b>2</b>	<b>2</b>	<b>15</b>

TPE was the reason for transfusion with the most frequent adverse events reported at 33 per cent. Most reactions were mild, although two patients experienced an anaphylactic reaction. Both these patients had transfusion indications aligned to the guidelines.

There is a risk of an adverse event with every transfusion. When a transfusion is not aligned to the guidelines, the patient is exposed to this risk without evidence of any benefit.

In this audit five patients (33 per cent of all reactions) experienced an adverse event associated with the FFP transfusion that was not aligned to the guidelines. It is fortunate that so few patients experienced adverse events given the large portion of transfusion episodes that were not aligned to the guidelines.

## Conclusion

**Table 28: All groups alignment**

Group	Total FFP episodes	Aligned n (%)	Not assessable n (%)
Warfarin reversal	57	26 (46)	-
TPE	52	11 (21)	-
Massive haemorrhage	344	344 (100)	-
Bleeding	141	48 (34)	11 (28)
Prior to surgery	90	31 (34)	7 (8)
Interventional radiology	32	7 (22)	-
Procedure	69	8 (12)	5 (7)
Chronic liver disease	47	14 (30)	-
Coagulopathy	39	7 (18)	6 (15)
DIC	21	3 (14)	-
<b>Total</b>	<b>892</b>	<b>499 (56)</b>	<b>29 (3)</b>

Previous Blood Matters audits in 2005 and 2008 found alignment in 34 and 32 per cent of FFP transfusion episodes, respectively. Alignment in this audit is 56 per cent (Table 28). If MHP events (344) are excluded, alignment is 28 per cent.

There are significant opportunities for improvement, particularly in the area of warfarin reversal, where the guidance is clear. While 100 per cent of use in MHP scenarios was deemed appropriate, at times the dosage of FFP given was inconsistent with ratio-based recommendations.

Table 29 outlines the number of FFP units that were used for aligned and non-aligned episodes.

**Table 29: FFP units used in aligned and non-aligned transfusion episodes**

Group	Total transfusion episodes	FFP units in aligned episodes	FFP units in non-aligned episodes
Warfarin reversal	57	46	63
TPE	52	43	186
Massive haemorrhage	344	866	-
Bleeding	141	87	165
Prior to surgery	90	69	101
Interventional radiology	32	11	46
Procedure	69	21	115
Chronic liver disease	47	26	73
Coagulopathy	39	11	57

Group	Total transfusion episodes	FFP units in aligned episodes	FFP units in non-aligned episodes
DIC	21	8	44
<b>Total</b>	<b>892</b>	<b>1188 322<sup>21</sup></b>	<b>850</b>

Further information that was not available when assessing alignment may have made some non-aligned transfusions aligned to current guidelines. However, there are still enough indications that alignment to the current guidelines is not occurring, and further education of clinicians is required.

Clear documentation to ensure vein to vein traceability of all blood products is needed for patient safety. Audit entries demonstrated the difficulty of traceability for such things as Prothrombinex-VF when it was available but the auditor was unsure if it had been given.

Transfusion scientists who receive the requests for FFP should be encouraged to question the appropriateness of orders, with support from appropriate clinical personnel within the laboratory.

Although there were few (15) reported transfusion reactions, five were non-aligned and thus unnecessary reactions. While most were mild reactions, there were two anaphylaxis reactions reported.

Blood products are not without risks and patients should be advised of these risks when consenting.

---

<sup>21</sup> Excludes MHP.

## Next steps

Blood Matters will disseminate the findings of the audit to health services, interested parties and relevant colleges to highlight the gaps to help improve knowledge and understanding among prescribing groups.

Education and endorsement of the guidelines for appropriate use of FFP should continue as a priority to pursue clarity and consistency in FFP prescribing and administration.

The following summary of appropriate use of FFP is a useful and simple guide to assist in circulating this message (Lifeblood, Prescribing FFP).

Evidence-based indications for FFP transfusion include:

- replacement of single coagulation factor or protein deficiency if no factor specific concentrate is available:
  - severe hereditary protein S deficiency
  - Factor V deficiency
- prevention of dilutional coagulopathy in the setting of massive transfusion
- DIC
- plasma exchange, for example, in TTP
- reversal of warfarin anticoagulation for:
  - clinically significant bleeding and/or life-threatening critical organ bleeding when PCC is not available
  - life-threatening critical organ bleeding (including intracranial haemorrhage) (150–300 mLs) in addition to PCC and vitamin K.

Transfusion of FFP is inappropriate in most other settings. As per the Evolve recommendations on low-value practices:

**Do not transfuse standard doses of fresh frozen plasma to correct a mildly elevated (< 1.8) international normalised ratio prior to a procedure.**

There is no evidence to support the prophylactic administration of fresh frozen plasma (FFP) to correct a mildly elevated international normalised ratio (INR) prior to procedure. The evidence supports the use of Vitamin K<sub>1</sub> and suggests the use of FFP correlated with an increased risk of intra-operative bleeding and/or increased risk of transfusion reactions.



## References

Australian Red Cross Lifeblood, 'Red cells', <<https://www.lifeblood.com.au/health-professionals/products/blood-components/red-cells>>.

Australian Red Cross Lifeblood 2020, *Blood book: Australian blood administration handbook*, <[https://transfusion.com.au/system/files/resource\\_library/bloodbook\\_firstedition\\_june2020revised.pdf](https://transfusion.com.au/system/files/resource_library/bloodbook_firstedition_june2020revised.pdf)>.

Australian Red Cross Lifeblood 2024, 'Use of fresh frozen plasma', <<https://www.lifeblood.com.au/health-professionals/clinical-practice/use-of-blood-components/use-of-fresh-frozen-plasma>>

Green L, Bolton-Maggs P, Beattie C, Cardigan R, Kallis Y, Stanworth SJ, Thachil J, and Zahra S 2018, 'British Society of Haematology Guidelines on the spectrum of fresh frozen plasma and cryoprecipitate products: their handling and use in various patient groups in the absence of major bleeding', *British Journal of Haematology*, <<https://doi.org/10.1111/bjh.15167>>.

Moylan S, Szabo F, Scott H, Kwok G 2008, 'The use of fresh frozen plasma at Royal Darwin Hospital: A retrospective audit', *Internal Medicine Journal*, vol 38, pp. 686–691.

Mujer MTP, Rai MP, Atti V, Dimaandal IL, Chan AS, Shrotriya S, Gundabolu K and Dhakal P 2020, 'An update on the reversal of non-vitamin K antagonist oral anticoagulants', *Advances in Hematology*, <<https://doi.org/10.1155/2020/7636104>>.

National Blood Authority 2023, *Patient blood management guidelines*, <<https://blood.gov.au/pbm-guidelines>>.

National Blood Authority 2022, 'Companion 26: Clinical indications for fresh frozen plasma', *Patient blood management guidelines* <<https://blood.gov.au/system/files/documents/companion-26-pbm-guidelines.pdf>>.

Royal Australasian College of Physicians Evolve and Australian and New Zealand Society of Blood Transfusion 2022, *Top-five recommendations on low-value practices* (point number 5 relates to FFP), <[https://anzsbt.org.au/wp-content/uploads/2022/03/FINAL-evolve\\_top-five\\_anzsbt.pdf](https://anzsbt.org.au/wp-content/uploads/2022/03/FINAL-evolve_top-five_anzsbt.pdf)>

Schofield WN, Rubin GL, Dean MG 2003, 'Appropriateness of platelet, fresh frozen plasma and cryoprecipitate transfusion in New South Wales public hospitals', *Med J Aust*, vol 178, pp. 117-121.

Tran HA, Chunilal SD, Harper PL, Tran H, Wood EM and Gallus AS 2013, 'An update of consensus guidelines for warfarin reversal', *Medical Journal of Australia*, vol. 198, pp. 198–199, <<https://doi.org/10.5694/mja12.10614>>.

Warner MA, Hanson AC, Weister TJ, Higgins AA, Madde NR, Schroeder DR, Kreuter JD and Kor DJ 2018, 'Changes in international normalized ratios after plasma transfusion of varying doses in unique clinical environments', *Hemostasis and Thrombosis*, vol. 127, no. 2, pp. 349–357.