Appropriateness of platelet, fresh frozen plasma and cryoprecipitate transfusion in New South Wales public hospitals

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ABSTRACT

Objectives: To estimate the appropriateness of transfusions of platelets, fresh frozen plasma (FFP) and cryoprecipitate using National Health and Medical Research Council and Australasian Society for Blood Transfusion guidelines (NHMRC/ASBT 2002).

Design and setting: Three separate retrospective surveys of medical records from 1 January to 31 August 2000 (1147 transfused patients) from 14 hospitals selected randomly from all public hospitals that use these blood products in New South Wales: five tertiary referral, five major metropolitan, and four major rural (base) hospitals.

Main outcome measures: Proportion of potentially inappropriate transfusions.

Results: 33% (136/414) of platelet, 37% (248/669) of FFP and 62% (37/60) of cryoprecipitate transfusions were assessed as inappropriate. By hospital type, 29% (75/259) of platelet transfusions were inappropriate at tertiary referral hospitals, 51% (40/78) at major urban hospitals, and 27% (21/79) at major rural hospitals. For FFP, 36% (112/313), 37% (80/216) and 39% (55/140) were inappropriate for referral, urban and rural hospitals, respectively. Cryoprecipitate was used almost exclusively at tertiary referral hospitals.

Conclusions: In terms of the NHMRC/ASBT guidelines on use of blood products, there is considerable inappropriate transfusion of platelets, FFP and cryoprecipitate in NSW public hospitals.

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THE TRANSFUSION of components derived from human blood underpins modern medicine. However, transfusion is not without risk. Furthermore, there is a lack of consensus among clinicians on criteria for appropriate use.[1] To address this void, in 2002 the National Health and Medical Research Council (NHMRC) and the Australasian Society for Blood Transfusion (ASBT) disseminated clinical practice guidelines for the use of blood components: red blood cells, platelets, fresh frozen plasma and cryoprecipitate.[1]

We have previously undertaken research on the appropriateness of red blood cell transfusion in selected major metropolitan hospitals in Sydney.[2] In that study, appropriateness was determined using criteria from a systematic review of the transfusion literature,[3] and we showed that 33% of red blood cell transfusions were potentially inappropriate.[2]

In the current survey, we used the NHMRC/ASBT guidelines as the "appropriateness" template for use of platelets, fresh frozen plasma, and cryoprecipitate in a sample of public hospitals in New South Wales.

METHODS

Hospital sample

Every public hospital in NSW was telephoned and asked whether it used platelets and fresh frozen plasma (FFP). From the list of hospitals that use these products, 14 were drawn at random, with the constraint that tertiary referral, major metropolitan and major rural (base) hospitals were represented by at least four hospitals each. The hospitals represent differences in size, location and facilities, as defined by the NSW Department of Health.[4]

On instructions from the chief executive officer at each hospital, medical records staff provided a printed list of patients transfused with platelets, FFP or cryoprecipitate between 1 January and 31 August 2000. These lists included a patient identifier, date of transfusion and product transfused.

Three separate samples were drawn from these lists, one for each blood product. At tertiary referral hospitals, a 5% random sample for platelets and FFP was drawn by computer. For major urban and major rural hospitals, all eligible patients were included. For cryoprecipitate, wherever transfused, all eligible patients were included.

Data collection forms

Three data collection forms, one for each blood product, were prepared in consultation with an experienced haematologist (M G D) and blood bank staff. These forms were piloted and sent for independent expert review (two haematologists working in hospitals not sampled for the study).

The information collected included demographic data, morbidity, pathology, treatments and blood product use, with dates, times and quantities.

Auditors

Eight research nurses with experience in auditing medical records were

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1: Appropriateness criteria

The criteria listed below follow the NHMRC/ASBT Clinical Practice Guidelines on the Appropriate Use of Blood and Blood Products.[1] They have been rephrased into a format suitable for application by computer.

Platelets

Appropriate if any one of the following applicable, likely to be *inappropriate* if none applicable:

- Prophylaxis for major surgery or invasive procedure and platelet count $< 50 \times 10^9$/L
- Massive haemorrhage/transfusion and platelet count $< 50 \times 10^9$/L
- Bone marrow failure and platelet count $< 10 \times 10^9$/L
- Bone marrow failure and platelet count $< 20 \times 10^9$/L with risk factors
- Excessive bleeding and cardiac bypass surgery

Fresh frozen plasma

Appropriate if any one of the following applicable, likely to be *inappropriate* if none applicable:

- INR or APTT high* and liver disease before major surgery or invasive procedure
- INR or APTT high and liver failure
- INR or APTT high and acute disseminated intravascular coagulation
- INR or APTT high and excessive bleeding
- INR or APTT high before an invasive procedure
- INR or APTT high before, during or after major surgery
- INR high and warfarin effect present and massive blood loss or emergency surgery
- correction of single factor deficiency when a specific factor was not available
- treatment of thrombotic thrombocytopenic purpura.

Cryoprecipitate

Appropriate if fibrinogen test result available and fibrinogen level < 1.0 g/L and clinical bleeding or trauma or invasive procedure or disseminated intravascular coagulation.

This criterion was also tested with fibrinogen level set at < 1.5 g/L, < 2.0 g/L and < 2.5 g/L.

APTT = activated partial thromboplastin time. INR = International normalised ratio of prothrombin time.
*"High" means above the hospital's normal range.

instructed on data abstraction procedures. Auditors worked in groups of two or three and were able to consult each other and the research team. During training, there was complete agreement between auditors on information abstracted.

Data collection

Data collection was planned for a two- or three-day period at each hospital. For each blood product category, hospitals were sent lists of patients sampled. Hospital staff delivered medical records to a room set aside for auditing. Each patient's total record was accessed. Pathology test results were obtained from medical records or pathology departments.

Data processing and analysis

Data were entered into the database by experienced contract staff. A research officer checked for inaccuracies and inconsistencies using frequency and cross-tabulation procedures. Missing data, usually pathology test results, were obtained by telephone. Errors were mostly due to differences in use of measurement units.

Once these procedures were concluded, the data were de-identified with regard to both the patient and the hospital. Purpose-written computer programs were used to apply the NHMRC/ASBT guidelines (Box 1). These programs were validated by comparison with manually scored results.

Statistical analyses

Results are presented as means or percentages. Confidence intervals for means were calculated as $\pm$ 1.96 times the standard error, and for percentages by the Blyth–Still–Casella method using StatXact.[5] SPSS was used for tabular analyses.[6]

Case weights were used to adjust for sampling differences whenever data from different hospital types were pooled. These were computed by multiplying the reciprocal of the proportion of a year between the start of the audit period (1 January 2000) and the date of the last transfusion episode audited at each hospital by the reciprocal of the sampling fraction at that hospital. Unadjusted data were used for statistical tests.

Ethics

This study used de-identified patient data from de-identified hospitals. The results are in summary form, with no identification of source. The Western Sydney Area Health Service Human Research Ethics Committee has stated that this is quality assurance, presenting no ethical concerns, and it therefore does not require submission for approval.

RESULTS

The results are for three separate and independent samples, one for each blood product. Sample size for each blood product, by hospital type, is included in Box 2.

There was a risk that lists of transfused patients provided by hospitals from their own computerised records were incomplete because of coding errors. We were satisfied that the lists were complete, except at one hospital, where there were fewer eligible patients than expected from estimated total blood product use. At this hospital, we drew a 5% random sample by computer from all admissions during the qualifying period and matched these against blood bank records. By this method, 59 additional patients who had received one of the three blood products were added to the sample.

Specialty at admission

The greatest use for all three products was for surgical and medical admissions, with lesser use by obstetrics and gynaecology, intensive care, and accident and emergency departments.

Within surgical departments at referral hospitals, the main use of the blood products was for cardiothoracic surgery (platelets, 55% [143/259]; FFP, 38% [69/183]; cryoprecipitate, 33% [20/60]). At major urban and rural hospitals, general surgery was the main surgical user of both products.

2: Morbidities or symptoms recorded at admission, by sample and hospital type

Morbidity or symptom present at admission	Platelet (*n* = 414)				Fresh frozen plasma (*n* = 669)				Cryoprecipitate (*n* = 64)	
	Referral (*n* = 259)	Urban (*n* = 78)	Rural (*n* = 77)	*P*†	Referral (*n* = 313)	Urban (*n* = 216)	Rural (*n* = 140)	*P*†	Referral (*n* = 60)	Urban (*n* = 4)
Infection, requiring antibiotics	53%	49%	47%	0.556	38%	46%	46%	0.140	37%	50%
Fever, higher than 37.5°C	58%	47%	57%	0.277	39%	50%	55%	0.003	43%	50%
Liver impairment/failure	22%	39%	15%	0.001	24%	32%	22%	0.053	30%	50%
Specific factor deficiency	0	3%	0	0.099	2%	1%	0	0.179	0	0
DIC with bleeding	6%	4%	1%	0.232	4%	2%	0	0.050	12%	25%
DIC without bleeding	2%	5%	4%	0.436	3%	4%	4%	0.575	5%	0
Haemorrhage (not DIC)	49%	60%	29%	0.001	64%	58%	56%	0.149	78%	75%
Surgery	59%	47%	30%	0.001	67%	46%	50%	0.001	82%	50%
Invasive procedure	79%	76%	35%	0.001	82%	71%	56%	0.001	85%	50%
Chemotherapy, currently receiving	26%	12%	22%	0.023	5%	6%	2%	0.274	7%	0
Heparin, before transfusion	27%	10%	7%	0.001	31%	19%	10%	0.001	30%	25%
Splenomegaly	7%	15%	3%	0.011	5%	7%	1%	0.021	5%	50%
Trauma	8%	4%	4%	0.232	12%	9%	16%	0.194	32%	25%
Haematological malignancy	36%	22%	38%	0.048	6%	8%	8%	0.757	5%	0
Other	53%	63%	53%	0.275	57%	58%	52%	0.468	44%	75%

† *P* value determined by χ^2 on counts (df = 2) for difference between hospital types. DIC = disseminated intravascular coagulation.

Within medical departments at referral hospitals, the main user of platelets was haematology (53%; 78/146); this was also the case at major urban hospitals (28%; 14/50). Oncology departments used 13% (19/146), 14% (7/50) and 16% (9/57) of platelets at referral, major urban and major rural hospitals, respectively. At referral hospitals, FFP was used mostly by cardiology (19%; 24/126), followed by haematology (14%; 17/126). At major rural hospitals, general medical departments were the main user of platelets (69%; 38/55) and of FFP (90%; 65/72).

3: Estimates for appropriateness of platelet transfusions (with 95% CIs)

	Tertiary referral (*n* = 259)	Major metropolitan (*n* = 78)	Major rural (*n* = 77)	All (*n* = 414)
Appropriate*	71% (65%–76%)	49% (37%–60%)	73% (62%–82%)	67% (62%–71%)
Inappropriate	29% (25%–36%)	51% (40%–63%)	27% (18%–38%)	33% (29%–38%)

Test of difference between hospitals: $\chi^2 = 14.48$, df = 2, $P < 0.001$. *See Box 1 for appropriateness criteria.

Morbidities and procedures

For all three blood products, admission for an invasive procedure or surgery was a major correlate of transfusion, as were presence of haemorrhage and, to a lesser extent, liver impairment (Box 3).

Platelet transfusions

Mean length of stay for the 414 patients in the platelet sample was 19 days (median, 11 days). During the episode audited, 73% of patients received a single pack of four units, 22% received a second four-unit pack and 5% received a third. Overall, the mean number of units given was 5.3. Platelet counts immediately before transfusion were $<10 \times 10^9$/L for 22% of patients, 10–20 $\times 10^9$/L for 15%, 20–50 $\times 10^9$/L for 20%, and $> 50 \times 10^9$/L for 43% of patients.

Appropriateness

Overall, 33% (95% CI, 29%–38%) of the platelet transfusions were potentially inappropriate (Box 2). There were significantly more inappropriate platelet transfusions at major metropolitan hospitals than at referral or major rural hospitals (Box 3).

Fresh frozen plasma transfusions

Mean length of stay for the 669 patients in the FFP sample was 16 days (median, 10 days). During the 24-hour period audited, most patients received a single FFP transfusion (mean, 3.3 units); 30% of patients received a second transfusion (mean, 3.0 units), and 13% received a third transfusion (mean, 3.1 units). The average total was five units per patient.

Appropriateness

Overall, 37% (95% CI, 33%–41%) of FFP transfusions were potentially inappropriate. There was no difference between hospital types (Box 4).

Following the guidelines, if no coagulation test results were available, then the FFP transfusion was classified as "inappropriate" unless it was used for the reversal of warfarin, or if there was a specific factor deficiency and the specific factor was not available.

If transfusions where no coagulation test result was available but the clinical factors of the criteria were met are included as "appropriate", then 26%, 32%, and 36% of FFP transfusions were inappropriate for referral, major metropolitan and major rural hospitals, respectively (overall, 30%).

If a specific factor deficiency was recorded and FFP given, then it was assumed that the specific factor product was not available.

Cryoprecipitate transfusions

On average, 5.7 units of cryoprecipitate were transfused per patient during the episode audited. Sixty-eight per cent of these patients were transfused once with cryoprecipitate (mean, 4.6 units), 27% were transfused twice (mean, 3.8 units), and 5% were transfused three times (mean, 2.7 units). Mean length of stay was 20 days (median, 14 days).

More than 80% of patients given cryoprecipitate had experienced massive blood loss, most were bleeding and were receiving other blood products. More than 80% had undergone surgery or an invasive procedure, and 75% were bleeding at the time of transfusion.

Appropriateness

Using the NHMRC/ASBT cut-off of < 1 g/L of fibrinogen, 62% of cryoprecipitate transfusions were potentially inappropriate. When the fibrinogen level was relaxed to < 1.5 g/L, 43% of transfusions were potentially inappropriate (Box 5).

As required by the guidelines, transfusions given to patients for whom a fibrinogen result was not available (15 patients) were classified as inappropriate. When these transfusions were excluded, the proportion of inappropriate transfusions was 49% (95% CI, 34%–64%).

4: Estimates for appropriateness of fresh frozen plasma transfusions (with 95% CIs)

	Tertiary referral (*n* = 313)	Major metropolitan (*n* = 216)	Major rural (*n* = 140)	All (*n* = 669)
Appropriate*	64% (58%–69%)	63% (56%–69%)	61% (52%–69%)	63% (59%–67%)
Inappropriate	36% (31%–42%)	37% (31%–44%)	39% (31%–48%)	37% (33%–41%)

Test of difference between hospitals: $\chi^2 = 0.26$, df = 2, $P = 0.879$. *See Box 1 for appropriateness criteria.

5: Estimates for appropriateness of cryoprecipitate transfusions (with 95% CIs)

	Risk factors* and plasma fibrinogen level (*n* = 60)			
	< 1 g/L	< 1.5 g/L	< 2 g/L	< 2.5 g/L
Appropriate†	38% (26%–52%)	57% (43%–69%)	68% (55%–79%)	72% (59%–83%)
Inappropriate	62% (48%–74%)	43% (31%–57%)	32% (20%–45%)	28% (18%–41%)

*Risk factors = any one or more of bleeding, invasive procedure, trauma, or disseminated intravascular coagulation, in addition to plasma fibrinogen less than levels shown in table (NHMRC recommended level for appropriate use is < 1 g/L). †See Box 1 for appropriateness criteria.

Discussion

Our finding that a substantial proportion of transfusions were inappropriate is consistent with other studies in Australia[7-9] and elsewhere.[10-19] The value of our study is that the results are based on a representative State-wide sample and provide statistically unbiased estimates for the three major categories of public hospitals. They can be applied generally to public hospitals in NSW, and possibly to public hospitals throughout Australia. Previous studies[7-19] have been limited to specific hospital types, or to selected cases or procedures.

The validity of a retrospective audit of patient medical records rests to some extent on factors outside the control of researchers. For some patients, the decision to transfuse may have been based on an observation, condition or event that was not recorded accurately, or at all. A serious lack of relevant information on patient records at a major teaching hospital in the US has been reported,[13] but in the limited context of orthopaedic surgery. The medical records we surveyed frequently ran to several volumes per patient and included all relevant information.

Guidelines aid, but do not replace, clinical judgement. In some cases the decision to transfuse may have been based on sound clinical judgement, even though at variance with the guidelines. We have previously described steps taken to allow for clinical judgement in applying guidelines, and have shown that for red blood cell transfusions the effect on appropriateness estimates is small.[2]

Our study used separate samples for each blood product. An alternative method would have been to draw a single random sample from all admissions during the qualifying period proportionately from the randomly selected hospitals. This would have included patients who had received transfusions and those who had not, so variation between these two groups could have been studied and related to appropriateness results for the transfused group. However, this task was beyond the scope of the study. In a single year in Western Australia, of 397 062 admissions to public hospitals 3.3% involved transfusion of a blood product.[20] On that basis, to find a sample of 1000 admissions in which a blood product was given (as for this project), more than 30 000 admissions would need to be reviewed. Even then, only 23% of those found would be for platelets, 10% for FFP and 1% or less for cryoprecipitate.[20]

Very few data were available for cryoprecipitate and the confidence intervals were wide. Even if the true estimate was at the lowest extreme of this interval, our findings suggest that clinical practice in the transfusion of cryoprecipitate is out of step with the NHMRC/ASBT guidelines for at least 48% of transfusions.

Our study has shown that blood product use in NSW will be substantially reduced if the recently published NHMRC/ASBT guidelines are widely adopted. We have previously shown that feedback to administrators and clinicians of results for their own hospital has minimal effect on inappropriateness rates for RBC transfusions.[2] Currently, Victoria and NSW are introducing collaborative improvement methods[21] aimed at changing clinical practice with regard to use of blood products. We intend repeating this survey in 2003–2004 to test the effect of these interventions.

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COMPETING INTERESTS

None identified.

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