NATIONWIDE QUESTIONNAIRE SURVEY OF TRANSFUSION MEDICINE IN FISCAL YEAR 2011 IN JAPAN

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Abstract:

In the survey conducted in 2011, among the 10,428 Japanese institutions receiving blood supply from the Japanese Red Cross Blood Center (JRCBC) (except the 4 provinces from eastern Japan affected by the Tohoku earthquake), the 4,322 institutions, which replied to the questionnaire, were enrolled. Concerning the establishment of the blood management system, except for the appointment of the responsible transfusionist, more than 90% of the large institutions (more than 300 beds) had good achievements. However, among the small institutions (less than 300 beds), the achievement rate ranged 50-70%, and no significant improvement was observed in the last 3 years. In especial, the appointment rate of the responsible transfusionist was as low as 51.8%. The number of blood products used per number of beds was almost unchanged, or slightly increased, in the fiscal year 2011. Concerning the implementation of the computer system for the safety of blood transfusion, the mobile terminal was available in 69.17% of the large institutions, with the rate of utilization higher than 80%, whereas in small institutions, both rates were below 20%. Among the 4,322 institutions, 50.8% had used more than 10 units of red cell concentrates (RCC) per day, and about 15.95% of the total RCC, and 28.58% of fresh frozen plasma (FFP) supplied by the JRCBC were used in these institutions. About 60.83% of the human hepatitis B immunoglobulin, a product with a national self-sufficiency ratio of 2%, and indicated for the prevention of hepatitis B infection in cases of accidental blood contamination or materno-fetal transmission, was used for the prevention of hepatitis infection after liver transplantation.

Keywords:

nationwide questionnaire survey on transfusion medicine, transfusion management system, appropriate blood transfusion, hospital fee for transfusion management

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自己血輸血とPatient Blood Management

Autologous blood donation and Patient blood management

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◎ Patient Blood Managementとは，患者の転帰を改善するために，多くの専門分野で明らかにされた科学的根拠に支えられた手技・手段を適宜用いることで実践される輸血回避戦略のことである．可能であれば同種血輸血を回避し無輸血手術を心がけ，輸血が必要な待機手術の場合は自己血輸血を積極的に導入する．近年，同種血の安全性は飛躍的に向上し，自己血輸血が同種血輸血に比べて無条件に安全・有用な輸血療法とはいい難い状況である．自己血輸血の優位性を保つためには各施設の院内自己血輸血管理体制の整備が重要であることはいうまでもないが，自己血輸血の適応判断，貯血計画，自己血採血・保管管理に至るすべての過程に関する適切なリスクマネジメントが必須条件である．採血時の細菌汚染と輸血時の過誤輸血にはとくに注意する．治療可能な貧血はできるかぎり術前に改善させ，自己血採血時には鉄剤とエリスロポエチン投与を行い，手術時の赤血球量を増やしておくことが重要である．また，自己血から作製した自己フィブリン糊の臨床利用は術後の局所出血や合併症を減らし，患者転帰を改善させるために有用である．

Key word：リスクマネジメント(risk management)，貯血式自己血輸血(preoperative autologous blood donation)，患者中心の輸血医療(patient blood management)，自己フィブリン糊(autologous fibrin glue)

Patient Blood Managementにおける自己血輸血とは

Patient Blood Management(PBM)とは，患者の転帰を改善するために多くの専門分野で明らかにされた科学的根拠(エビデンス)に支えられた手技・手段を適宜用いることで実践される輸血回避戦略のことである[1,2]．つまり輸血を受ける患者の安全管理および転帰を，一人ひとりの患者で検討し，患者中心の輸血医療を心がける考え方である．同種血は原料がヒトに由来するために，病原体などの伝播の可能性があり，また免疫反応の発生や免疫能の抑制がみられる(表1)．そのため，同種血輸血は，有意に術後の感染症や，癌再発を増加させる[3]．TRICC(Transfusion Requirements in Critical Care Trial)研究では赤血球輸血のトリガー値をHb 7.0 g/dLとし，目標Hb値を7.0～9.0 g/dLに設定した制限輸血群と，自由輸血群に分けて30日後の死亡率を評価したところ，制限輸血群のほうが生存率は高く，とくに重症臓器障害群や50歳以下では有意差をもって制限輸血群で高い生存率を示した[4]．心臓外科手術[5]や一般外科手術[6]でも，1単位以上の赤血球輸血を行った群では早期の感染症や合併症発生リスクが無輸血群に比べて有意に高く，患者予後を悪化させる．可能であれば同種血輸血を回避し無輸血手術を心がけ，輸血が必要な待機手術の場合は自己血輸血を積極的に導入する．

手術時や外傷時の大量出血，また白血病治療において同種血輸血は必要不可欠な補充療法であり，救命に重要である．一方，待機手術における貯血式自己血輸血(以下自己血輸血)は同種血輸血の回避により感染症伝播や免疫反応などのリスク

表 1　同種血輸血と自己血輸血のリスクの比較

	同種血輸血	自己血輸血
感染症などの伝播	HBV，HCV，HIV，HTLV-Ⅰ梅毒，HAV，HEV，PV-B19，CMV，プリオン，細菌など	細菌(可能性は同種血より高い) 同一保管庫では感染症陽性血液による汚染の可能性あり
免疫応答・抑制	発熱性副作用，アナフィラキシー反応 TRALI，輸血後 GVHD，同種免疫抗体の獲得 易感染性，癌再発など	基本的にはなし (白血球由来のサイトカインによる発熱性副作用はまれに存在する)
過誤輸血	ABO 型・Rh 型の血液型不適合輸血	バーコードラベルがないと過誤輸血は起こりやすい
その他	TACO，高カリウム血症，低カルシウム血症など	
	頻回輸血による鉄沈着症	長期保存で高カリウム血症は高度

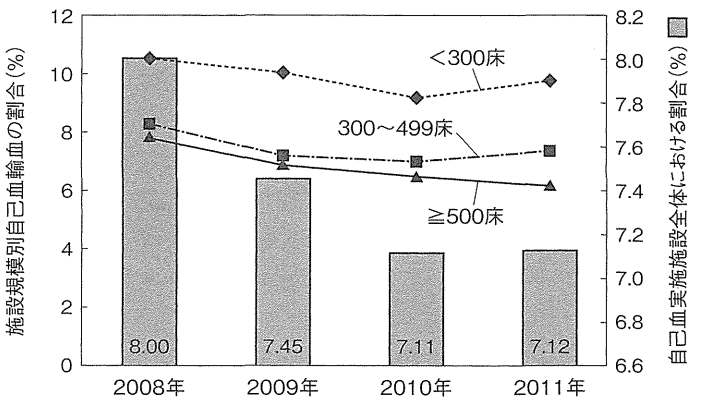

図 1　施設規模別の全赤血球使用量に占める自己血使用量の割合
自己血輸血の割合(%)＝全自己血輸血使用量(単位)×100/(全同種赤血球使用量＋全自己血輸血使用量)として計算した．

を避けることができる有力な方法として整形外科や心臓外科をはじめとする各領域において実施されてきた．同種血輸血のリスクが解明されるに従って自己血輸血の意義，すなわち絶対的な優位性が社会的にも認識されてきた．しかし，同種血輸血副作用対策として，HBV，HIV，HCV のウイルス抗原，抗体検査の導入や改良に加えてウイルス核酸増幅検査(NAT)の導入をはじめ，輸血後 GVHD 防止の輸血用血液の事前放射線照射，さらに，初流血除去や保存前白血球除去などの効果的な対策が進められてきた．その結果，献血血液の安全性は飛躍的に向上し，自己血輸血が同種血輸血に比べて無条件に安全有用な輸血療法とはいい難い状況である．その結果，全赤血球輸血に占める自己血輸血の占める割合は近年徐々に低下傾向であり，とくに 500 床以上の大規模医療施設において著明である(図 1)．

輸血療法の実施に関する指針のなかで，自己血輸血は“院内の輸血管理体制が適正に確立している場合は同種血輸血の副作用を回避しうるもっとも安全な輸血療法であり，待機的手術患者における輸血療法として積極的に推進することが求められる”と記載されている[7]．自己血輸血の優位性を保つためには各施設の院内自己血輸血管理体制の整備が重要であることはいうまでもないが，自己血輸血の適応判断，貯血計画，自己血採血・保管管理に至るすべての過程に関する適切なリスクマネジメントが必須条件である．もっとも安全で理想的な輸血療法といわれる自己血輸血であるが，一歩間違えれば患者にとって危険な輸血に豹

表 2　海外の自己血輸血の現状

国名	貯血式	Epo の保険適応	回収式	希釈式
USA	Very low 血液製剤の 3%程度	民間保険	○	Very low
ドイツ	○	○	○	Very low
イギリス	×	△	○	Very low
オランダ	Very low	○	○	Very low
スウェーデン	×	○	○	Very low
オーストラリア	Low	○	○	Very low
韓国	Very low	本人負担	○	Very low

稲葉頌一：恵まれたわが国の自己血輸血．第 36 回自己血輸血看護セミナー教育講演，神奈川，2011.4.23．（稲葉頌一先生のご厚意により）

変しうることも認識しておかなければならない．国際的にみて積極的に自己血輸血を推進しているのは日本とドイツくらいであり，エリスロポエチンの自己血輸血への保険適応がないアメリカでは全赤血球使用量のわずか 3%程度まで低下している（表 2）．その理由は，①同種血輸血の安全性の向上，②対費用効果（cost-effectiveness）の低さ，③待機時間の長さ，⑤術前患者への脱血負荷，⑥採血技術の徹底・教育の困難さ，および，⑦廃棄自己血の多さなどがあげられる．日本においては自己血輸血は同種血回避への患者の意思表示であり，担当医は患者の意思を尊重し，できるだけ出血の少ない手術を心がけ，丁寧な止血処置を行い，自己血のみで手術を終えることができるように努力してきた．その結果，人口当りの赤血球使用量は国際的にみても少ない．

自己血輸血のリスクマネジメント

1. 自己血輸血管理体制の整備

安全で適正な自己血輸血を実施するためには自己血輸血担当部門を設置し，自己血輸血責任医師を任命し，自己血担当検査技師を配置する．輸血療法委員会で自己血輸血マニュアルを作成し，自己血輸血全般に関する検討を行い，院内のルールを決める．例年行っている輸血アンケート調査では自己血輸血を実施している施設は回答施設の 1/3 を占めており，その院内輸血管理体制は約 80%の整備率であり，自己血輸血未実施施設と大きな差が認められた（図 2）．輸血管理体制が整っていない施設での自己血輸血は PBM からいえば避けたい．

2. 自己血輸血の適応および適応外判断[8)]

自己血輸血の判断は自己血輸血責任医師あるいは担当医が行うが，一般的適応をつぎに示す．

① 自己血輸血のインフォームド・コンセント（IC）が得られる場合

② 術中に循環血液量の 15%以上の出血が予想され，輸血を行う可能性が高い場合

③ まれな血液型や免疫抗体を有し，適合血の入手が困難である場合

④ 信仰上の理由などで同種血輸血を受け入れない場合

⑤ 臓器移植や骨髄移植のドナーで，ゼロリスクが求められる場合

⑥ 患者の全身状態を正しく評価し，医師が適応と認めた場合

PBM の立場から患者の転帰を考えたうえで自己血輸血が適応外と判断される場合を示す．

① 細菌感染者

② 重篤な心疾患患者…大動脈弁狭窄症，不安定狭心症，過去 6 カ月以内の心筋梗塞，チアノーゼ性心疾患，心不全（NYHA Ⅲ度以上）など

③ 出血素因のある患者

④ 意識消失を繰り返す患者

⑤ 胎盤血行不全の妊婦

⑥ そのほか，医師が適応外と認めた場合（ウイルス感染症陽性者の貯血に関しては輸血療法委員会で検討する）

3. 貯血計画

自己血輸血の方法には貯血式（液状保存法，凍

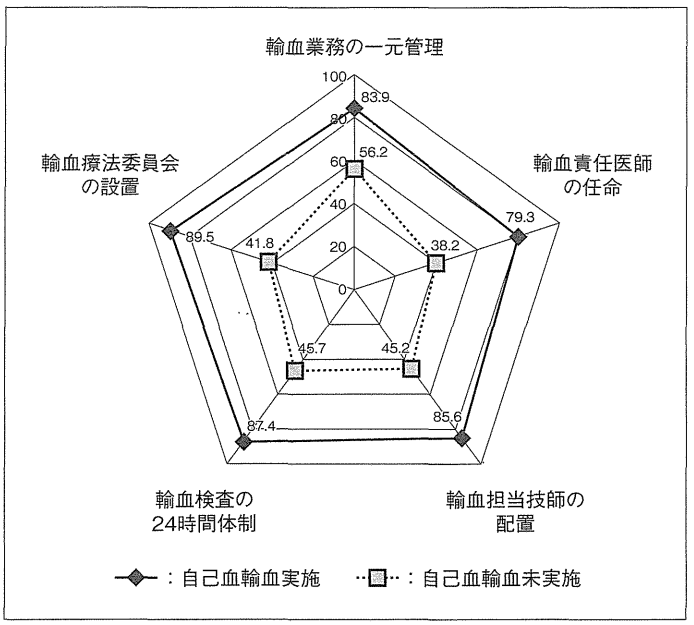

図 2　自己血輸血実施施設と未実施施設における院内輸血管理体制の整備度の比較
2011 年輸血業務・輸血製剤年間使用量に関する総合的調査による．

結保存法)，希釈式，回収式(術中，術後)があるが，もっとも多い貯血式液状保存について述べる．

貯血式液状保における採血は，日本自己血輸血学会が提示している貯血式自己血輸血実施基準[9]に準じて行われているが，年齢，体重の制約はなく，Hb 値 11.0 g/dL 以上あれば採血している．1 回採血量を循環血液量の 10%程度(体重が 50 kg 以下の場合は 400 mL×体重/50 が目安)とし，週 1 回を原則としている．80 歳以上の高齢者貯血に際しては合併症のリスクが高く，年齢基準を決めている施設もある[10]．これは患者の転帰を考えたうえでの判断であり，重要である．術中の輸血を自己血のみで賄うためには術前の貧血を改善しておく必要がある．手術の 1 カ月以上前に Hb 値をチェックし，貧血を認めた場合にはその原因を検索し，鉄剤やビタミン B12，葉酸，エリスロポエチン製剤(erythropoiesis stimulating agents：ESA)などで治療可能であれば，できるかぎり術前に貧血を改善させておく[11,12]．そうすることによって自己血貯血も安全に実施でき，とくに心疾患患者や高齢者など貧血状態が望ましくない場合に有効である．さらに，術前に貧血であると同種血輸血を追加する可能性もあり，術後の感染症や合併症を増やす要因にもなるため，自己血採血時には鉄剤と ESA 投与を行い手術時の赤血球量を増やしておく．

① 鉄剤投与

400 mL 採血で 200 mg の鉄を失い，経口鉄剤は小腸にて 20%の吸収率であるため，1 週間ごとに 400 mL 採血する場合，200 mg/7 日×100/20≒150 mg/day(フェロミア 3〜4 錠/day)となる．経口鉄剤による吐気などの消化器症状が強い場合は静脈投与を行うが，アナフィラキシーショックや鉄過剰による肝障害に注意する．

② ESA投与

(1) 貯血量が 800 mL 以上で，1 週間以上の貯血期間がある

(2) (1)を満たし，貯血開始時の Hb 濃度が体重 70 kg 以上の場合は 13 g/dL 以下，体重 70 kg 未満の場合は 14 g/dL 以下の症例

(3) 1 回 24,000 単位を週 1 回皮下注する(患者の Hb 値や予定貯血量などに応じて投与回数や投与期間を適宜増減する)

しかし，Hb 値を上げすぎて血栓症や血圧上昇

などの副作用が起こらないように注意する．

4. 自己血採血・保管管理

穿刺による細菌混入に注意する．佐川らの報告[13]では3,735件中3件(0.08%)に細菌汚染が認められ，日赤データでは初流血除去を行うことにより1/3に減少させることができたと報告している[14]．国内の自己血輸血を実施している施設ではほとんど初流血除去は行っていないために，ある一定の頻度で細菌汚染は発生する可能性があるために，保存中の血液製剤の色調変化に注意する必要がある．とにかく入念な消毒が重要であり，通常は消毒用エタノールで皮膚の汚れを落とし，10%ポピヨンヨードを塗布後2分間程度放置し乾燥後穿刺する．

自己血採血時の副作用としては血管迷走神経反射(Vasovagal reflex：VVR)，神経損傷，動脈穿刺，出血性ショック，接触性皮膚炎などがあるが，VVR以外はほとんど経験しない．日赤の献血者のVVR発生率は0.85%程度であり，全国大学病院輸血部会議副作用ワーキング調査結果では0.78%であった[15]．採血中には患者から目を離さず，異常を察知したら採血を中止し，輸液に切り替えバイタルを慎重にモニターし，遅滞なく対処することが重要である．穿刺する人を固定し，患者が安心できる環境での採血が望ましく，採血時の患者安全が確保できないようであれば自己血貯血は行わない方がよい．

採取した自己血バッグには患者の直筆のサインをもらい，温度管理された専用の保冷庫で保存する．バーコードがあればコンピュータ確認後入庫する．ウイルス感染症陽性血液は区別して保管し，最悪の事態(過誤輸血など)のときにも被害を最小限に止められるようにする．

5. 自己血輸血

過誤輸血は同種血輸血と同様に起こりうるため，細心の注意が必要である．過誤輸血例は過去11年間(2000～2010年)で123例の報告があり，年間10例程度発生している[16]．原因は患者・バッグ取り違えが多く，職種別には看護師が多い．日本輸血・細胞治療学会はベッドサイドでの輸血の安全性を高めるために学会認定・臨床輸血看護師制度を設立した．

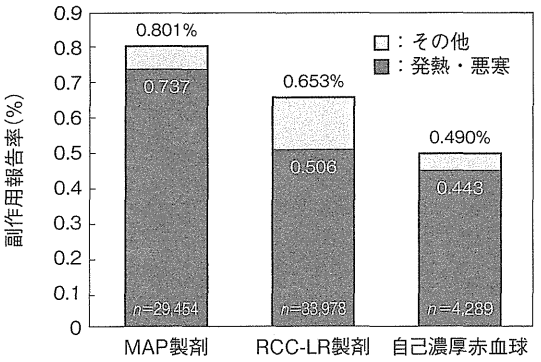

図3 同種血および自己血輸血に伴う副作用報告例
(虎の門病院：2001～2011年)
虎の門病院における2001～2011年の11年間における同種赤血球輸血および自己濃厚赤血球輸血時の副作用発症状況．保存前白血球除去製剤(RCC-LR)はMAP製剤に比べて副作用報告件数が減少した．

同種血輸血時の副作用は2009年度輸血副作用サーベイランス体制の確立に関する研究(浜口班)での全国12施設(7,332病床)の結果によると，赤血球製剤0.86%，血小板製剤5.36%，血漿製剤1.18%であり，赤血球製剤では発熱・悪寒がもっとも多く32.6%を占め，発疹・蕁麻疹が16.9%であった[17]．自己血輸血時の副作用はまれとされているが，血圧低下，細菌汚染，輸血関連循環負荷(TACO)，溶血反応，発熱・悪寒などの報告があり，発熱性非溶血性輸血副作用の一部は，保存中の白血球由来のサイトカインIL-1，IL-6，TNF-αなどの蓄積や総合作用により引き起こされると考えられる[18]．当院で過去11年間(2001～2011年)に使用した自己濃厚赤血球製剤4,289件で21件(19件は発熱・悪寒)の副作用報告があり，その40%が何らかの手術関連のものとしても残りの60%にあたる12例(0.29%)は輸血関連副作用と考えられた(図3)．自己血でも保存前白血球除去の有効性は多く報告されており[19]，対費用効果を含めエビデンスを蓄積し臨床導入を考えたい．いずれにしても自己血輸血だから副作用はないと考えるべきではない[18]．

自己フィブリン糊の利用

手術を受ける患者にとって手術が成功し，術後出血が少なく，合併症もなく早期に退院できることが理想的である．局所で起こる出血，縫合不全，

感染症などの合併症防止としてヒトプール血漿を用いた市販のフィブリン糊が多くの外科領域で使用されている．一方，自己血から作製した自己クリオプレシピテート(自己クリオ)にヒトトロンビンとカルシウムを同時に使用する自己フィブリン糊も市販のフィブリン糊と同等以上の臨床効果があり，広く用いられている[20]．2012年4月の保険改定で自己生体組織接着剤作成術が新規保険収載されたが，従来から行われてきた用手法による自己クリオ作製術は2年後の保険適応に期待する．自己フィブリン糊は止血凝固作用と組織接着剤作用ばかりでなく，組織修復促進作用や局所感染症予防作用を有し術後の合併症対策としては理想的である．患者の転帰の改善する戦略としてはおおいに期待できる．

おわりに

同種血の安全性が格段に向上し，cost-effectivenessの点からも自己血の優位性を示すことが容易でなくなった．逆に，自己血貯血時のVVRなどの副反応や細菌汚染のリスクなどのマイナス因子が存在する．輸血を受ける患者の転帰を改善するためには自己血輸血のすべての過程において適切なリスク管理を行うことが必須条件であり，安全で適正な輸血療法の実施に向けて努力する必要がある．近い将来の輸血用血液製剤の供給状況や新興感染症など不透明であるため，PBMの立場からも自己血輸血を推進すべきである．

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The Current State of Transfusion Medicine and Cell Therapy

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Transfusion medicine in Japan is supported by the blood donation system. After the cabinet's decision to unify the blood donation system to the Japanese Red Cross Blood Center (JRCBC) in 1964 triggered by the tragic incidence involving the Ambassador from the U.S., Mr. Edwin Oldfather Reischauer, a blood center was established in every prefecture in Japan, and since 1969, all blood products for transfusion have originated from blood donation. Afterward, the blood component transfusion became the standard procedure; the blood collection criteria were revised. In 1986, the 400-mL blood donation and component donation were introduced, which constitute the basis of the present donation system. Since 1985, the use of plasma derivatives, especially albumin, has been extremely high, approximately 1/3 of the total produced worldwide being consumed in Japan, which depended on up to 95% importation. In reaction to a corrective action request by the WHO, the Japanese government released guidelines and criteria for implementing the appropriate use of blood products, which were subsequently revised, and the presently defined "Guidelines of Transfusion Practice" and the "Criteria for the Use of Blood Products" were announced. With the implementation of these measures, the use of albumin has significantly decreased, and the domestic self-sufficiency rate has achieved levels surpassing 50%, but recently, as a result of the gap in price between national and international products, the trend has temporarily leveled off.

The safety of blood products has remarkably improved with the introduction of screening tests for donated blood. In addition to detection of the serological markers of hepatitis and human immunodeficiency virus, the nucleic acid amplification test for viral markers was introduced in 1999, and furthermore, the provision of irradiated blood to prevent the harmful graft-versus host disease was started in 1998. Also, since 2004, the pre-storage leukocyte reduction of all blood products was introduced to prevent non-hemolytic transfusion reactions, and since 2006, diversion of the initial blood flow during blood collection was implemented to prevent bacterial contamination of blood products. Additionally, for the prevention of transfusion-related acute lung injury, more than 99% of the 400 mL-derived fresh-frozen plasma is derived from male blood donors, avoiding to the extent possible the transfusion of plasma from multiparous women, which may contain the causative anti-leukocyte antibodies.

Following the Product Liability Act of 1995, in 2003, the Law for the Stable Provision of Safe Blood Products was enacted, which established 1) the improvement of the safety of blood products, 2) the domestic self-sufficiency through blood donation, as a general rule, and the guarantee of stable provision, 3) the promotion of appropriate use, 4) the clarification of the roles of medical and paramedical staff dealing with blood transfusions, based on the fundamental principles for guaranteeing fair and transparent blood business operations. In 2004, "the relief system for the victims of virus transmission through biological products" was established, and in 2005, the "guideline for the look back study of blood products" was implemented. In addition, the blood transfusion management

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system was consolidated, consisting of nomination of a physician responsible for blood transfusion, assignment of a medical technologist responsible for blood transfusion, unified management of the transfusion service, establishment of a hospital transfusion committee, and a 24-hours-a-day provision of blood transfusion tests in each institution. Since 2006, institutions that fulfill these requirements and perform safe and appropriate transfusion practices have been paid a "transfusion management fee." The Japan Society of Transfusion Medicine and Cell Therapy (JSTMCT) adopts a team approach to perform safe blood transfusion, and for this purpose, promotes certification systems, including, in addition to the certified physician, the certified medical technologist in transfusion medicine, the JSTMCT-certified transfusion nurse, including autologous blood transfusion nurse, apheresis nurse, and clinical transfusion nurse. However, in small institutions, the establishment of an appropriate transfusion management system is difficult, thus joint transfusion committees were established in each prefecture, which are working not only for the promotion of appropriate use and reduction of blood wastage, but also for standardization of transfusion practices. In 2012, the requirements for the "transfusion management fee" were revised, and divided into facility requirements and appropriate use requirements.

According to the annual survey conducted by the JSTMCT, the number of institutions receiving blood supply from the JRCBC has surpassed 11,000, among which, 90% are small institutions with fewer than 300 beds. The total amount of blood supplied by the JRCBC progressively decreased until 2006, as a result of the promotion of appropriate use and the reduction of invasive surgical procedures. However, since 2007, consumption of all blood products has increased. One reason for this is that Japan has become a super-graying society, with an increase in the elderly population with cardiovascular diseases, who require blood transfusion. Thus, in order to guarantee a stable blood supply, additional promotion of blood donation is indispensable. As a measure to overcome this problem, the age of male blood donors was raised to 17–69 years for the 400-mL blood donation and to 18–69 years for platelet apheresis donation. Also, promotion of autologous blood transfusion is essential. Autologous blood transfusion is covered by the Japanese Universal Health Insurance, as well as the use of erythropoietin (ESA), thus, it is actively performed in Japan. Implementation of certification of nurses by the Japanese Society of Autologous Blood Transfusion, is expected to enhance promulgation of safe autologous blood transfusion, based on blood collection by expert physicians or nurses with essential knowledge on autologous blood collection, and adequate preservation of collected blood on specific refrigerators. However, the use of ESA for the treatment of chemotherapy-induced anemia (CIA) is not covered by Japanese Universal Health Insurance, and the transfusion of red blood cell concentrates remains as the only available treatment. In an attempt to guarantee the patient's freedom of treatment choice, a field survey on CIA is being conducted in conjunction with the Japan Society of Clinical Oncology, in an attempt to clarify the sample size that would benefit the use of ESA.

In 2007, the "Guideline for actions against intraoperative critical hemorrhage," which defines the prompt coordinated action of the surgeons and anesthesiologists in the field, the transfusion service and the JRCBC, in case of massive hemorrhage, was announced. However, fibrinogen preparation is not yet available for cases of dilutional coagulopathy due to massive transfusion, and a field survey is ongoing to determine the number of cases developing massive hemorrhage, in an attempt to clarify the significance of the expansion of its indication.

Cell therapy can be divided into stem cell transplantation and the other cell therapies. In Japan, more than 1,000 unrelated-donor stem cell transplantations are being performed annually. Moreover, autologous stem cell transplantation is mainly performed using frozen-preserved peripheral blood stem cells (PBSC), maintained at −80°C in CP-1 solution (a mixture of DMSO and HES) as the preservative, which is a simple preservation procedure, and is being largely applied. Since 2010, the unrelated PBSCT emerged as a new alternative, and increased use of PBSCT is expected hereafter. On the other hand, the use of cord blood stem cell mini-transplantation for the elderly is increasing rapidly, dependent on the availability of cord blood stem cells through the cord blood bank network. In 2010, the "Guideline for the manipulation of blood cells in-hospital" was announced, and adequate

manipulation of cells by the transfusion services was stimulated. Concerning the other cell therapies, bone marrow-derived cells or peripheral blood monocytes are being used for regenerative medicine targeting angiogenesis or cardiac muscle regeneration, and also LAK- or DLI-based immunotherapies are ongoing. Additionally, granulocyte transfusion for cases of severe infection during bone-marrow failure in the post-stem cell transplantation period is being performed in accordance with the "Granulocyte transfusion guideline." Hence, striking remarkable progress is expected to be made in the field of cell therapy, and the role of transfusion services, which deals with it, is also expected to be more important.

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Online reporting system for transfusion-related adverse events to enhance recipient haemovigilance in Japan: A pilot study

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ABSTRACT

Background: A surveillance system for transfusion-related adverse reactions and infectious diseases in Japan was started at a national level in 1993, but current reporting of events in recipients is performed on a voluntary basis. A reporting system which can collect information on all transfusion-related events in recipients is required in Japan.
Methods: We have developed an online reporting system for transfusion-related events and performed a pilot study in 12 hospitals from 2007 to 2010.
Results: The overall incidence of adverse events per transfusion bag was 1.47%. Platelet concentrates gave rise to statistically more adverse events (4.16%) than red blood cells (0.66%) and fresh-frozen plasma (0.93%). In addition, we found that the incidence of adverse events varied between hospitals according to their size and patient characteristics.
Conclusion: This online reporting system is useful for collection and analysis of actual adverse events in recipients of blood transfusions and may contribute to enhancement of the existing surveillance system for recipients in Japan.

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1. Introduction

Haemovigilance is defined as the surveillance of transfusion-related adverse reactions occurring in donors and in recipients. The ultimate purpose of haemovigilance is to prevent adverse events caused by blood products to ensure maximum safety. Various haemovigilance systems have been implemented around the world, with a different approach in different countries [1–6].

In Japan, the Japanese Red Cross Society (JRCS) is the sole provider of labile blood products, and controls blood collection, processing and supply nationwide. The JRCS, in cooperation with the national government, has been collecting data on transfusion-related adverse reactions and infections nationwide since January 1993 [7]. Epidemiological surveillance in donors is being performed to ensure their health as well as the safety and quality of blood components. For recipients, suspected adverse reactions, including infections related to the blood products, are reported from medical institutions to the JRCS on a voluntary basis, and nearly 2000 suspected cases were reported each year from 2004 to 2008 [7]. The JRCS investigates the relationship between transfusion and the reported adverse events. Based on the analysis, the JRCS evaluates blood safety with the government to take appropriate and immediate measures, as required, in JRC blood centers and medical institutions. The existing surveillance system for recipients has functioned well over a number of years, and most of the reported cases have been relatively moderate to severe. However, comprehensive data on adverse transfusion reactions in all recipients are unavailable. We therefore need to establish an improved system for monitoring recipients nationwide.

We have developed an alternative reporting system to collect data on all transfusion-related reactions in recipients. A pilot study of this online surveillance system has been performed since January 2007. Here, we describe our online system and present the data collected by 12 medical institutions from January 2007 to December 2010.

2. Materials and methods

2.1. Participants in the pilot study

Seven university hospitals (Aichi Medical University, 1014 beds; Tokyo Jikei University, 1075 beds; Yamanashi University, 600 beds, Tokyo Medical University Hachioji Medical Center, 621 beds; Yamaguchi University, 759 beds; Kurume University, 1186 beds; Kumamoto University, 843 beds) initially participated in the pilot study in 2007, and five small-scale hospitals with fewer than 300 beds (Kuroishi General Hospital, Minami Tama Hospital, Shibetsu City Hospital, Sanraku Hospital, Yao General Hospital) joined this study 2 years later.

2.2. Online system

In the participating hospitals, doctors or nurses monitored transfusion-related reactions at 0, 5, and 15 min after starting transfusion, at the end of transfusion, and within 6 h after finishing the transfusion. Severe adverse events and infections were determined after detailed diagnosis in JRC blood centers. These data were gathered in the hospital transfusion department. Doctors or transfusion specialists in the department reported the data every 2 months via the worldwide web (https://www.1597532.net/). Data were collected in the National Institute of Infectious Diseases, and analyzed statistically every 2 months. The online surveillance system was password-protected, and respondents were provided with an identification and password.

2.3. Statistics

All statistical analyses were performed by the Student *t* test. Probability values less than 0.05 were considered statistically significant.

3. Results

3.1. Reporting system and classifications

Our online surveillance system was designed to collect all transfusion-related reactions in recipients. The system monitored the total number of transfusions of three types of labile blood component: red blood cells (RBC), platelet concentrates (PC) and fresh-frozen plasma (FPP), in each reporting period (Fig. 1). The number of transfusion reactions, and clinical signs and symptoms were also collected. They were classified into 16 categories, as shown in Fig. 2. Additionally, information on diagnostic data was collected (Fig. 3). Transfusion-related adverse events were categorized into non-haemolytic reactions, haemolytic reactions and post-transfusion infectious diseases. The non-haemolytic reactions included: severe allergic reaction, transfusion-related acute lung injury (TRALI), transfusion associated circulatory overload (TACO), post-transfusion purpura (PTP) and transfusion-associated graft-versus-host disease (TA–GVHD). Definitions of these severe transfusion reactions were in accord with the International Society of Blood Transfusion [8]. For non-haemolytic reactions or infections, those events not covered by the diagnoses listed were assigned to the category "Others".

3.2. Number and frequency of adverse events from 2007 to 2010

We investigated transfusion reactions collected by 12 hospitals from January 2007 to end of December 2010 (Fig. 4). During the period, 241,225 bags of labile blood products were used in 12 hospitals: 133,993 bags of RBC, 55,861 bags of FFP and 51,371 bags of PC (Fig. 4B). The proportions of RBC, FFP and PC were 55.5%, 23.2% and 21.3%, respectively, of the total amount of blood bags (Fig. 4A). There were 3,539 transfusion-related adverse events reported during the period (Fig. 4B). Of the reported reactions, the blood product that accounted for highest proportion of adverse events was PC (60.4%), followed by RBC (24.9%) and FFP (14.7%) (Fig. 4A). When the frequency of transfusion reactions was calculated according to the total number of bags, the overall incidence of adverse events was 1.47% (Fig. 4B). PC was found to induce transfusion reactions at a

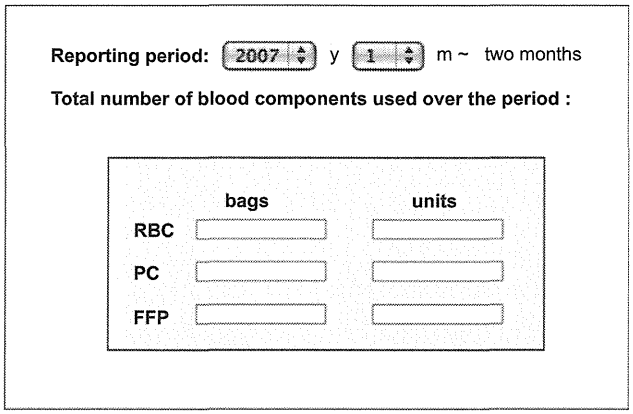


Fig. 1. Online surveillance system (1): Screenshot of the total number of the three labile blood components (bags and units) used over each reporting period. RBC: red blood cells; FFP: fresh frozen plasma; PC: platelet concentrates.

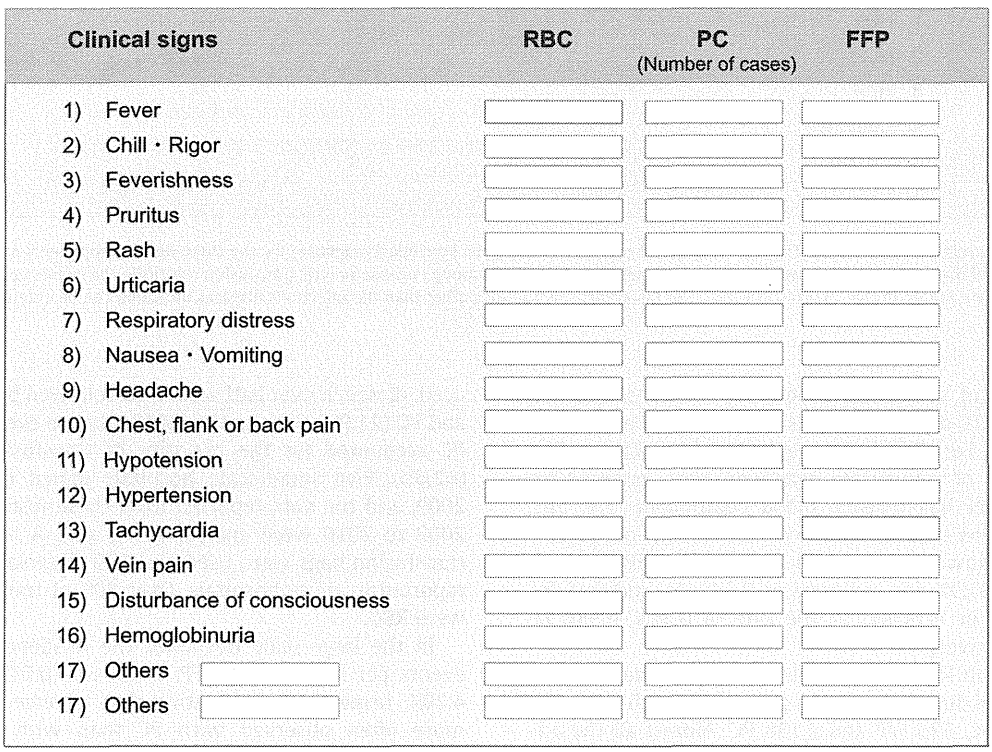


Fig. 2. Online surveillance system (2): The total number of transfusion reactions by clinical signs for the three blood components used over the reporting period is presented. Clinical signs are classified into the 16 categories indicated. Fever: more than 38 °C or a 1 °C or more increase from the baseline; hypotension: a decrease of more than 30 mmHg from the baseline; hypertension: an increase of more than 30 mmHg from the baseline; tachycardia: more than 100 times/min for adult, modified according to age for children. Any findings other than the 16 signs can be entered as free text in "Others".

rate of 4.16%. The incidence of transfusion reactions with RBC and FFP was 0.66% and 0.93%, respectively. The annual incidence of adverse events showed a similar tendency (RBC < FFP < PC) every year, as shown in Fig. 4C.

3.3. Types, clinical signs and diagnoses of adverse events

Next, we analyzed the types, clinical signs and diagnoses of adverse events collected from 12 hospitals over 4 years. The types of adverse events among the different blood components were diverse (Fig. 5A). Febrile non-haemolytic transfusion reactions (FNHTR) were more often found with RBC than with FFP or PC. Allergic reactions were observed significantly more often with FFP or PC than with RBC. In the reactions to RBC, 36.6% were FNHTR and 31.2% were caused by allergic reactions. Respiratory distress, a hypotensive reaction, and a hypertensive reaction accounted for 3.9%, 8.0% and 4.4%,

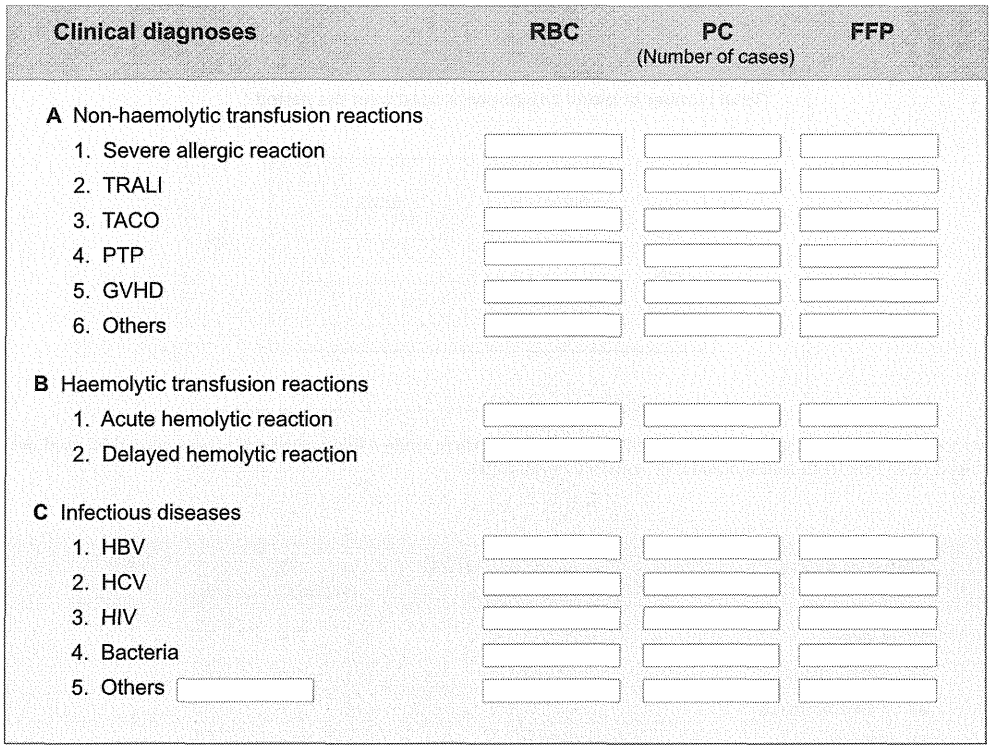


Fig. 3. Online surveillance system (3): The total number of transfusion reactions by clinical diagnoses for the three blood components over the period is presented. Clinical diagnoses are classified into the three categories indicated. Among non-haemolytic transfusion reactions, the events not included in the diagnoses listed are placed in the category "Others". For infections, any findings other than the infectious diseases indicated can be entered as free text in "Others".

respectively, of the transfusion-related events. For PC, more than 80% of the reactions were allergic and 11.6% were FNHTR. For FFP, 70.8% were allergic reactions. The clinical signs of transfusion reactions were assessed by the events per bag of each blood component (Fig. 5B). In the reactions to RBC, fever occurred in 0.2% of transfusion bags, followed by urticaria in 0.15%. In FFP, pruritus occurred in 0.23% and urticaria in 0.54%. PC induced fever, pruritus or urticaria at the rate of 0.32%, 0.98% or 2.85%, respectively.

As shown in Fig. 4B and Table 1, 3,539 reaction events were collected during the 4-year period, of which 881 were caused by RBC, 520 FFP and 2,138 PC. Almost all the adverse reactions reported were "Others" in non-haemolytic reactions. Severe allergic reaction, TRALI or TACO were reported at the rate of 0.1–1.3% for each blood component. In the adverse events for RBC, four cases of hemolytic reactions and one case of HBV infection were reported.

3.4. Variation in the incidence of adverse events by medical institutions

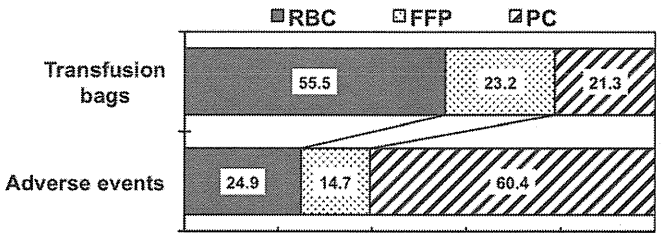
We compared the incidence of adverse events in seven large-scale university hospitals with that in five small-scale hospitals with fewer than 300 beds. Seven large-scale hospitals participated in this pilot study since 2007 and the data reported by these hospitals from 2007 to 2010 were analyzed (Fig. 6A). A total of 231,662 transfusion bags were used, of which over half were RBC, followed by FFP (23.6%) and PC (21.9%). Among the 3,410 adverse events reported, PC accounted for the majority of transfusion reactions (62.6%). Five small-scale hospitals joined this study in 2009, and the data reported from these institutions from 2009 to 2010 were analyzed (Fig. 6B). A total of 9,563 transfusion bags were used and 129 adverse events were reported in these hospitals. Over 80% of transfusion bags were RBC.

In the large-scale hospitals, the incidence of adverse events per bag of RBC, FFP or PC was 0.61%, 0.94% and 4.20%, respectively, indicating that adverse events were more often observed with PC than with FFP or RBC (Fig. 6C). On the other hand, in the small-scale hospitals, the incidence of adverse events per bag of RBC, FFP or PC was 1.46%, 0.98% and 0.59%, respectively, indicating that the adverse events were more often observed with RBC than with PC or FFP (Fig. 6C). There was a significant statistical difference in the incidence of transfusion-related adverse reactions per bag of RBC or PC in the large-scale vs. the small-scale hospitals.

4. Discussion

In our new reporting system, we analyzed the data collected from 12 medical institutions from 2007 to 2010. During the period, 241,225 labile blood products were used in these hospitals. Considering the number of blood

A. Rates of transfusion bags and adverse events by kinds of blood components



B. Incidence of transfusion reactions by kinds of blood components

	RBC	FFP	PC	Total
No. of transfusion bags	133,993	55,861	51,371	241,225
No. of adverse events	881	520	2,138	3,539
Incidence (%)	0.66	0.93	4.16	1.47

C. Annual incidence of adverse events by kinds of blood components

Year	RBC (%)	FFP (%)	PC (%)	Total (%)
2007	0.54	0.63	3.44	1.16
2008	0.61	0.69	4.22	1.45
2009	0.79	1.19	5.36	1.91
2010	0.70	1.30	3.77	1.49

Fig. 4. Proportions of transfusion bags and adverse events from 2007 to 2010. (A) The proportion of transfusion bags for each blood component and the proportion of adverse events ascribed to each component. (B) The incidence of transfusion reactions by type of blood component. (C) The annual incidence of adverse events by type of blood component.

products distributed nationwide during the 4 years, we monitored approximately 1% of the bags distributed in Japan for each blood component (data not shown). During this time, 3,539 transfusion-related adverse events were reported in this system, and the overall incidence of adverse events per bag was 1.47%. This incidence was higher than the reports from other countries which had 2.2–4.2 events per 1,000 blood products distributed [9–12]. We observed that the rate of reported cases varied considerably among seven university hospitals (data not shown). The true incidence of adverse events may be obscured by misdiagnosis. The lack of agreed definitions negatively affects data collection. The difficulty in the diagnosis of transfusion reactions also leads to misreporting. Therefore, sharing diagnostic criteria for transfusion-related reactions is required. Other studies in Japan have demonstrated similar incidences of adverse events by type of blood component (Kurata Y. et al., personal communication, 2007). Therefore, it is likely that our results reflect the real incidence of adverse events for blood products distributed in Japan.

PC (4.16%) gave rise to statistically more adverse events (6-fold) than RBC (0.66%) and FFP (0.93%). Our results were concordant with a previous report in Switzerland [12], although it should be noted that all products of PC in Japan are from single apheresis donor. PC was found to frequently induce fever, pruritus or urticaria. PC recipients, most of whom suffer from hematological diseases, tend to receive frequent blood transfusions. The repeated alloimmunization with PC may induce a high incidence of adverse events. We found that the incidence of adverse events varied between the university hospitals and the small-scale hospitals, based on the number of beds and patient characteristics. In Japan, most patients with hematological diseases have a check-up in large-scale hospitals including university hospitals. Actually, the five small-scale hospitals had no patients with hematological diseases, and their incidence of adverse events to PC was only 0.59%.

This online reporting system makes it possible to collect all transfusion-related adverse events in recipients rapidly. The database can perform calculations on the reported information automatically, and the results, such as the total number of adverse events or the incidence of adverse events, are fed back to participants continuously. This feedback should contribute to improving the safety of transfusion therapy in each medical institution. There are

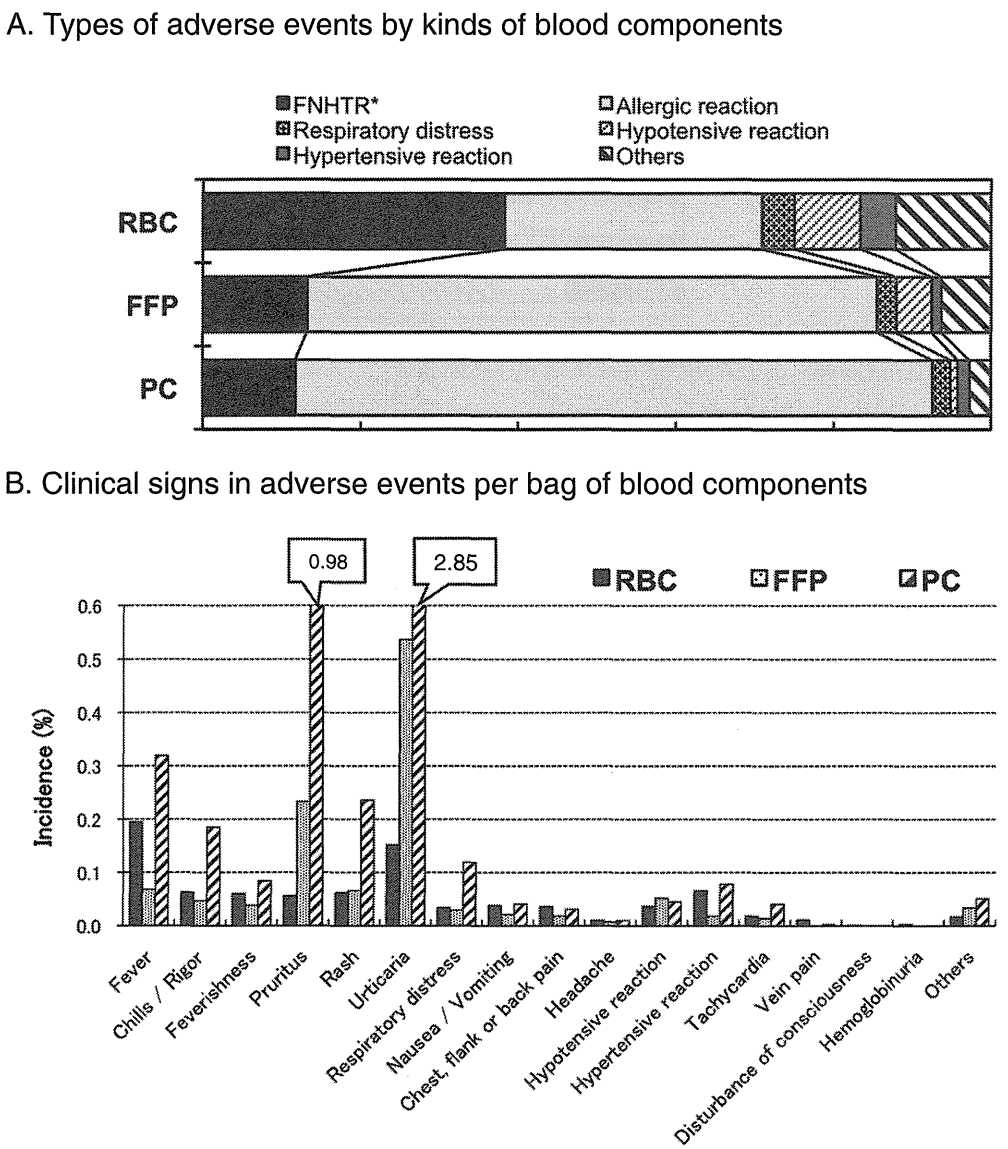


Fig. 5. Types of adverse events and clinical signs of adverse events by blood component. (A) Proportions of adverse events by type of blood component. (B) Incidence of clinical signs of adverse events by type of blood component. FNHTR: febrile non-haemolytic transfusion reaction.

a few limitations in this system. The focus of our study was only on three types of labile blood components. Information about the appearance of antibodies for each blood product was not collected. In addition, reporting of information on transfusion errors, including incorrect blood component transfusion and near-miss events, was out of the scope of the system. Almost all the adverse reactions collected for 4 years were "Others" in non-haemolytic reactions. As regards the severity of transfusion-related reactions, we speculated that the majority reactions were relatively mild. We did not confirm the individual cases of serious adverse events in this system during the period of the pilot study.

In the future, more detailed analyses of data collected by this system will be needed to determine how to improve the transfusion service and formulate new strategies to reduce adverse transfusion reactions. Almost all European Union countries have established a haemovigilance system and the number of haemovigilance systems outside Europe is steadily increasing. National haemovigilance systems linked to an international network will be indispensable to ensure the safety and quality of blood transfusions. Thus, an international standardized and centralized method for data collection and reporting is required. We have to continue to carefully monitor and compare the incidence of adverse events between Japan and other countries, in order to promote preventive measures in the manufacture of blood products in Japan, and other necessary steps to reduce transfusion-related events.

Table 1
Clinical diagnosis of transfusion-related adverse events from 2007 to 2010.

	RBC cases (%)	FFP cases (%)	PC cases (%)
Non-haemolytic transfusion reaction			
Severe allergic reaction	4 (0.5%)	7 (1.3%)	8 (0.4%)
TRALI	4 (0.5%)	3 (0.6%)	3 (0.1%)
TACO	4 (0.5%)	1 (0.2%)	0
PTP	0	0	0
GVHD	0	0	0
Others	861 (97.7%)	509 (97.9%)	2127 (99.5%)
Haemolytic transfusion reaction			
Acute hemolytic reaction	3 (0.3%)	0	0
Delayed hemolytic reaction	1 (0.1%)	0	0
Infectious diseases			
HBV	1 (0.1%)	0	0
HCV	0	0	0
HIV	0	0	0
Bacteria	0	0	0
Others	0	0	0
Total all cases	881	520	2138

The number of events and their frequency for each blood component are shown. TRALI, transfusion-related acute lung injury; TACO, transfusion associated circulatory overload; PTP, transfusion purpura; GVHD, graft-versus-host disease; HBV, hepatitis B virus; HCV, hepatitis C virus; HIV, human immunodeficiency virus.

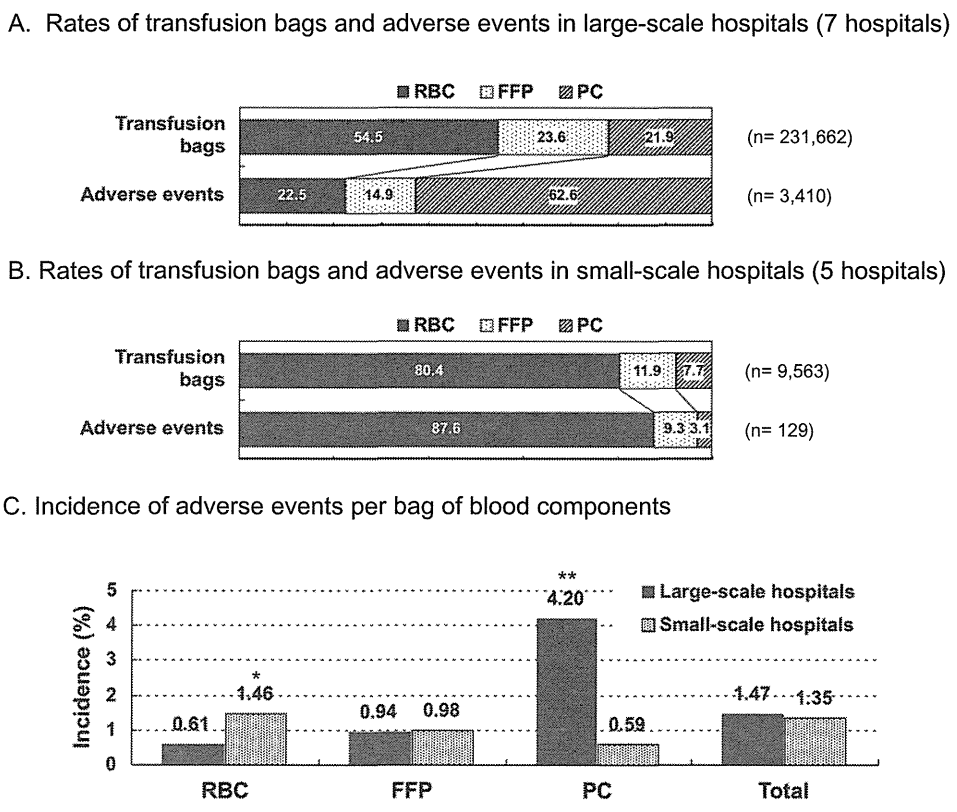


Fig. 6. Comparison of use of transfusion bag type, adverse events and incidence between large-scale and small-scale hospitals. Proportions of type of blood component and adverse events by type of blood component in seven large-scale university hospitals (A) and in five small-scale hospitals (fewer than 300 beds) (B). (C) The incidence of adverse events per bag of each blood component in large-scale and small-scale hospitals. $^{*}p < 0.05$ compared with large-scale hospitals; $^{**}p < 0.01$ compared with small-scale hospitals.

5. Conclusions

We have developed a comprehensive online system for the collection of all adverse reactions in recipients related to blood transfusion. Despite the limitation of our current system described above, this system is effective for collection and analysis of actual adverse events in recipients and can be used to enhance the existing surveillance system in Japan.

Conflict of interest statement

The authors declare no competing financial interests.

Acknowledgments

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—【原　著】— Original —

がん化学療法に伴う貧血に関する実態調査報告

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がん化学療法に伴う貧血（Chemotherapy-induced anemia：CIA）に関する実態調査を2010年9月～11月に実施した．がん種別の化学療法実施症例数・実施率と輸血率・輸血使用量，貧血の程度並びに輸血に影響した要因などを分析し，日本での現状を探った．

対象とした8つのがん種（乳房，肺，胃，大腸・直腸，肝臓，婦人科系，泌尿器系，悪性リンパ腫）の調査期間の化学療法実施率は5.4～13.6%（平均9.2%）であり，化学療法実施症例中での輸血率は1.6～24.0%（平均7.5%），1人当たりの赤血球輸血量は3.9～7.3単位（平均5.9単位）であった．

上記の結果をもとに厚生労働省の全国患者統計から，1年間にわが国でがん化学療法時の貧血に対して使用される赤血球輸血量を推計すると約14.6万単位となり，赤血球製剤総供給量の2.2%に相当した．またHb10g/dl以下の年間CIA患者数は約17.2万人で，化学療法実施患者の40%と推測された．輸血に影響する可能性のある因子として，化学療法および放射線療法の履歴，並びにプラチナ製剤の使用が挙げられた．

化学療法開始前のHb値の平均，開始後の最低Hb値の平均は，赤血球輸血を実施した症例では，9.5g/dlおよび6.9g/dlであり，輸血を実施しなかった症例では11.6g/dlおよび10.4g/dlであった．また，各がん種ともHb 8.0g/dl以上で赤血球輸血を実施した症例は少数にとどまる一方，Hb6.9g/dl以下であっても赤血球輸血を実施しなかった症例も多数みられた．輸血副作用の比率は全国集計と比して大きな差異はみられなかった．

以上よりがん化学療法に伴う貧血に対しての赤血球輸血は極力控えられている実態が明らかとなった．患者のQOL向上のためには，同種血を使用せずにHb値の上昇を期待できる他の代替療法（赤血球造血刺激因子製剤など）について検討する必要があると考えられた．

キーワード：がん化学療法，貧血，輸血率，輸血使用量，輸血副作用

はじめに

悪性腫瘍は，わが国の死因統計の第一位で発症数，死亡症例数とも一貫して増加傾向にあり，総合的な予防・治療対策が重要な疾患である[1)]．部位別に最近の死亡率の推移をみると，上位を占める胃・大腸などの消化管，肺，肝臓などの癌は横ばいから微減傾向であるが，乳癌は増加傾向を示している．がん化学療法のめざましい進歩により，2000年以降，生存期間のさらなる延長が得られるようになり，がん患者が長期に亘って化学療法を受ける機会も増えていると推測される．しかしながら治療期間が長くなるにつれて有害事象の出現率が上がり，薬剤耐性も顕在化しやすいという課題も有している．

がん化学療法に伴う貧血（Chemotherapy induced anemia：CIA）は最も頻度の高い有害事象の一つであり，患者QOLに支障をきたすだけでなく治療を継続する上で大きな障碍にもなっている．労作時の動悸・息切れ，全身倦怠感などの貧血に伴う症状の改善と全身

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〔受付日：2013年1月18日，受理日：2013年2月21日〕

状態の維持のために，欧米を中心とする多くの国々では赤血球造血刺激因子製剤(erythropoiesis stimulating agents：ESA)と輸血療法の両者が使用可能であるが，日本ではCIAに対するESA製剤の薬事承認が未だなされていないため輸血療法のみが唯一の対応法となっている．

上記の状況を踏まえ，日本癌治療学会と日本輸血・細胞治療学会が共同で実施したCIAに関する実態調査結果を解析し，問題点および今後解決すべき課題について考察したので報告する．

方　法

調査対象施設は，日本癌治療学会の代議員所属施設および日本輸血・細胞治療学会の認定医制度指定施設を中心とした164施設とし，基本調査（一次調査）と詳細調査（二次調査）に分けて実施した．

調査対象期間は2010年9月～11月の3カ月間に設定し，乳がん，肺がん，胃がん，大腸がん，肝臓がん，婦人科系がん，泌尿器系がん，悪性リンパ腫の8種類のうち，調査協力可能ながん種を各施設が選択，回答する形式とした．まず一次調査では，各施設毎に調査可能で症例数の多い5種類のがん種を選択し，上記の調査対象期間に受診した患者数(A)を集計した．次に，Aのうち，がん化学療法を実施した手術不能進行がん患者数（悪性リンパ腫の場合には進行性・再発性のがん患者数)(B)を集計し，さらにBのうち，赤血球輸血を実施した患者数（C1）と使用赤血球製剤の総単位数(C2)を集計した．また各施設で赤血球輸血を実施する際のトリガー値も調査した．二次調査では一次調査で報告された化学療法実施症例から患者ID番号の下一桁を指定し，無作為に患者の詳細データを取得した．調査項目は，①患者基本情報として，年齢，性別，化学療法・放射線療法の履歴，今回の化学療法の種類，血栓性疾患の病歴，②患者血液データとして，化学療法開始前と開始後の最低赤血球数，Hb値，血小板数，網状赤血球数，フェリチン，およびHb値が10g/dl以下の期間，8g/dl以下の期間，③輸血関連情報として，赤血球製剤・血小板製剤の使用量，副作用の有無とその症状，輸血実施判断に影響した要因などとした．統計学的解析にはスチューデントのT検定を用い，有意水準は5%とした．患者プライバシーを保護するため，必要事項を抽出した後は，データベースから患者IDと名前は削除し，仮番号で管理した．また原則として各施設の倫理委員会の承認を得ることを条件とした．

なお，今回調査対象のがん種の日本全体での推計患者数を平成23年度の厚生労働省の患者調査[2]から引用した．

結　果

一次調査の回答施設数は65施設（回答率39.4%）であり，内訳は大学病院・分院47施設，公立・自治体病院7施設，国立病院機構の病院3施設などであった．

各がん種の回答症例数は乳房でA：20,324人，B：2,430人，C1：39人，C2：179単位，肺でA：10,466人，B：1,420人，C1：58人，C2：258単位，胃でA：11,922人，B：969人，C1：94人，C2：409単位，大腸・直腸でA：16,718人，B：1,653人，C1：58人，C2：309単位，肝臓でA：6,542人，B：353人，C1：18人，C2：71単位，婦人科系でA：13,552人，B：1,112人，C1：114人，C2：655単位，泌尿器系でA：17,654人，B：676人，C1：61人，C2：291単位，悪性リンパ腫でA：9,900人，B：1,227人，C1：294人，C2：2,151単位で，合計値はA：107,078人，B：9,840人，C1：736人，C2：4,323単位であった．

二次調査は一次調査回答施設のうち47施設（回答率87.4%）から回答があった．がん種別の症例数は，乳房213例，肺169例，胃140例，大腸・直腸309例，肝臓56例，婦人科系234例，泌尿生殖器系135例，悪性リンパ腫347例で合計1,603例であった．

癌化学療法時の推計輸血患者数と赤血球輸血量を表1に示した．今回調査対象のがん種の日本全体での推計患者数は合計121.0万人であり，全てのがん種の推計患者数150.6万人の80%を占めた．進行がんで化学療法を実施した比率は平均9.2%であり，乳房，肺，悪性リンパ腫での実施率が比較的高かった．その中での輸血実施率は平均すると7.5%だったが，実施率の低いがん種（乳房，大腸・直腸など）と高いがん種（婦人科系，悪性リンパ腫など）が認められた．化学療法実施率と輸血実施率から推計輸血患者数を算出すると合計で6,783人となり，推計患者数の0.6%に相当した．また1症例当たりの輸血量は平均5.9単位でがん種間での差異は小さかった．推計輸血量が最も多かったのは化学療法実施率・輸血実施率が高く，かつ症例当たりの輸血量が多かった悪性リンパ腫の11,734単位，次いで総患者数が多く，輸血実施率の高かった胃の6,381単位の順で，8種類のがん種合計では36,527単位だった．調査で得られた3カ月間のデータを4倍した年間推計輸血量は約14.6万単位となった．これは平成23年度の赤血球製剤の総供給量654万単位の2.2%に相当する量であった．

赤血球輸血のトリガー値（Hb値）は，特に決めていない，7g/dl，8g/dlの順に多く，6g/dlとしている施設もあった（表2）．各がん種での輸血に影響する因子をみたところ，性別・年齢に差異はみられず，化学療法・放射線療法の履歴および薬剤の種類では有意差は認めないものの，若干の差異がみられた（表3）．プラチナ製剤を含むレジメン，同製剤を含まないレジメン，