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Inpatient recipients of packed red blood cells in a university medical center in Poland in 2018–2019

Piotr F. Czempik[1], Aleksandra Spień[2], Marta Oleksa[2], Dawid Wiśniewski[2], Łukasz J. Krzych[1]

[1]Department of Anaesthesiology and Intensive Care, Faculty of Medical Sciences in Katowice, Medical University of Silesia, Katowice, Poland
[2]Students' Scientific Society, Department of Anaesthesiology and Intensive Care, Faculty of Medical Sciences in Katowice, Medical University of Silesia, Katowice, Poland

Summary

Background: *Availability of epidemiologic data on recipients of packed red blood cells (RBCC) is crucial for demand planning and policy development in the blood supply and delivery system, as well as patient blood management (PBM). The obvious limitation of large databases is lack of specific clinical data. We aimed to assess inpatient recipients of RBCC in our institution in the years 2018–2019 to prepare a comprehensive institutional PBM program.*

Material and methods: *We performed a retrospective analysis of all RBCC recipients in our institution between 1 January 2018 and 31 December 2019. Basic demographic and clinical data of patients who received RBCC were retrieved from hospital electronic health records. We calculated the percentage of hospitalizations with RBCC transfusion, average number of RBCC units transfused during single hospitalization in different hospital departments.*

Results: *During the study period there were 1312 (1.41%) hospitalizations with RBCC transfusion. The median age of transfused patients (1 hospitalization in a hospital department = 1 patient) was 62 (IQR 45–71) years. Among these patients there were 528 (40.2%) men and 784 (59.8%) women. Among patients who were transfused with at least a single RBCC unit, 33.8% were diagnosed with malignancy and 20.3% with non-malignant gastrointestinal disease or gastrointestinal bleeding. Single RBCC transfusions accounted for 85.4% of all transfusions. RBCC unit were transfused most frequently in patients hospitalized in the intensive care unit (ICU) (44.6% of hospitalizations). In departments of Gastroenterology & Hepatology, ICU, Gastrointestinal Surgery, Gynecology & Obstetrics, 2749 units (68.9%) RBCCs were transfused. In the ICU and surgical departments (gastrointestinal, gynecology & obstetrics, neurosurgery) 53.5% of all RBCCs were transfused.*

Conclusions: *The results show that more than half of RBCC recipients were patients with primary diagnosis of malignancy, non-malignant gastrointestinal disease, or gastrointestinal bleeding. RBCCs were most frequently transfused in patients hospitalized in the ICU. More*

Correspondence address: Piotr F. Czempik, MD, PhD, Department of Anaesthesiology and Intensive Care, Faculty of Medical Sciences in Katowice, Medical University of Silesia, Medyków Street 14, 40–752 Katowice, phone: +48 032 789 42 01, e-mail: pczempik@sum.edu.pl

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than half of all RBCCs were transfused in patients hospitalized in the ICU and surgical departments. In the development phase of inpatient PBM program particular attention should be focused on the abovementioned groups of patients.

Key words: packed red blood cell transfusion, blood use in hospital wards, patient blood management

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Introduction

Availability of epidemiologic data on recipients of packed red blood cells (RBCC) is crucial for demand planning and policy development in the blood supply and delivery system, as well as patient blood management (PBM). Access to large sets of data may be challenging due to fragmented and competitive systems of blood supply and delivery, an example of which are data from some administrative regions in the United States of America [1]. The way to overcome these limitations may be creation of large databases that can be used to carry out observational studies. There are only a few examples of such a large databases, the most recent example comes from Scandinavian countries [2, 3]. The obvious limitation of large databases is lack of specific clinical data. An example of meeting both requirements is a donor-component-recipient database from 4 blood centers and 12 hospitals in the United States [4]. There is another similar database under development in Canada [5]. Moreover, epidemiological data on blood recipients may be useful for strengthening PBM. PBM is a strategy of conserving a patient's own blood through multiple measures [6]. PBM measures should be aimed at potential recipients of RBCC.

We aimed to assess inpatient recipients of RBCC in our institution in years 2018–2019 in order to prepare a comprehensive institutional PBM program.

Material and methods

We performed a retrospective analysis of all RBCC recipients in our institution between 1 January 2018 and 31 December 2019. Our institution is a large medical center affiliated with a medical university, with 644 hospital beds in two locations. The hospital performs both surgical and non-surgical activity. Gastrointestinal surgery department admits patients scheduled for gastrointestinal oncologic and non-oncologic surgery. Oncologic surgery department is a small unit that admits patients scheduled for oncologic surgery of mostly breast, thyroid and pancreas. Both oncology and clinical oncology departments provide chemotherapy, hormonotherapy, and immunotherapy. Clinical pharmacology department specializes in optimizing pharmacotherapy of chronic conditions. The intensive care unit (ICU) is a mixed medical-surgical department.

Basic demographic and clinical data of patients who received RBCC were retrieved from hospital electronic health records (AMMS, Asseco Medical Management Solutions, Poland): age, sex, primary diagnosis, hospital department, number of RBCC units transfused. As decision to transfuse RBCC could depend on a primary diagnosis or a hospital department where a patient was hospitalized, we assumed that 1 hospitalization in the hospital department corresponded to 1 patient. We categorized primary diagnoses [according to International Statistical Classification of Diseases and Related Health Problems 10th revision (ICD-10)] into broader groups: malignant tumor (patients not undergoing: surgery, radiotherapy, chemotherapy, hormonotherapy, immunotherapy during hospitalization with RBCC transfusion), gastrointestinal disease, oncologic surgery (gastrointestinal, breast, thyroid), malignancy on chemotherapy/hormonal therapy/immunotherapy (duodenum, breast, pancreas, testis, colon, brain, bladder, lung, stomach, ovary), non-oncologic surgery (gastrointestinal, thyroid), iron-deficiency anemia, medical (diabetes mellitus 2, chronic obstructive pulmonary disease, chronic kidney disease), malignancy on radiotherapy (pharynx, esophagus, larynx, colon, lung, bladder, brain, breast, uterus, cervix, stomach, kidney, sigmoid, rectum), hematological disease requiring RBCC transfusion (non- iron-deficiency anemia, acute myeloid leukemia, myelodysplastic syndrome, chronic myeloid leukemia, chronic lymphocytic leukemia, multiple myeloma), cardiovascular disease (heart failure, heart arrhythmia, hypertension). We decided on a separate category for iron-deficiency anemia due to its high prevalence and the fact that it should be treated with iron supplementation — not RBCC transfusion. Moreover, our analysis was made with the introduction of PBM program in mind. We calculated the percentage of hospita-

lizations with RBCC transfusion and the average number of RBCC units per hospitalization with RBCC transfusion in different hospital departments during the study period.

Due to the retrospective and observational nature of the study the local bioethics committee waived the requirement for ethical approval (PCN/0022/ /KB/41/20). All patient data were anonymized.

Results

During the study period there were 92 532 hospitalizations, 33 834 (36.6%) male and 58 698 (63.4%) female. There were 1312 (1.41%) during which at least a single RBCC unit was transfused. The characteristics of the study population is presented in Table 1.

Table 2 presents the primary diagnoses of the physicians as entered on the RBCC order for transfusion.

Among patients who received at least a single RBCC unit, as much as 33.8% were diagnosed with malignancy [malignant tumor; surgery (oncologic); malignancy (chemotherapy), malignancy (radiotherapy)]. Other diagnoses of patients who were transfused were non-gastrointestinal bleeding, non-oncologic gastrointestinal disease, gastrointestinal bleeding. The patients with these 4 top primary diagnoses, as entered by clinicians in an RBCC order, represented 51.3% of all transfused subjects (Table 2).

The highest number of hospitalizations with RBCC transfusion occurred in the following departments: gastroenterology & hepatology, gynecology & obstetrics, gastrointestinal surgery, ICU. These hospitalizations constituted 63.1% of all hospitalizations with RBCC transfusion. The percentage of hospitalizations with RBCC transfusion was highest in the ICU (44.6%) (Table 3).

The hospital wards responsible for using the highest number of RBCC units were the same 4 departments where the highest number of hospitalizations with RBCC transfusion took place (Table 4). In departments of gastroenterology & hepatology, ICU, gastrointestinal surgery, gynecology & obstetrics, 2749 units (68.9%) of RBCC were transfused. ICU and surgical specialties (gastrointestinal, gynecology & obstetrics, neurosurgery) used 53.5% of all RBCC units. In the study period there were 3991 RBCC units transfused during 1312 hospitalizations with transfusion, which corresponded to a mean number of 3.0 RBCC units per hospitalization. Mean number of RBCC units per hospitalization with RBCC transfusion varied from 1.3 ± 0.5 (Neonatology) to 4.0 ± 4.6 (ICU) (Table 4).

Table 1. Study population characteristics

Parameter	Value
Age (IQR) all patients [years]	62 (45–71)
Age (IQR) men [years]	63 (50–70)
Age (IQR) women [years]	61 (44–72)
Sex (male/female) [number, %]	528 (40.2)/ /784 (59.8)
Single unit/multiple unit RBCC transfusions [number, %]	1120 (85.4%)/ /192 (14.6)

IQR — interquartile range, RBCC — packed red blood cells

Table 2. The primary diagnoses of patients who received RBCC transfusion

Primary diagnosis	Hospitalizations [number (%)]
Malignant tumor	263 (20.0)
Bleeding (non-gastrointestinal)	144 (11.0)
Gastrointestinal disease (non-oncologic)	136 (10.4)
Gastrointestinal bleeding	130 (9.9)
Surgery (oncologic)	86 (6.6)
Malignancy (chemotherapy)	81 (6.1)
Bleeding (pregnancy and postpartum)	73 (5,6)
Infection	61 (4.6)
Surgery (non-oncologic)	42 (3.2)
Critically ill	40 (3.0)
Medical	39 (3.0)
Iron-deficiency anemia	37 (2.8)
Hematological disease	36 (2.7)
Neonatal	32 (2.4)
Intracranial bleeding	29 (2.2)
Stroke (ischemic/hemorrhagic)	23 (1.8)
Benign tumor	21 (1.6)
Cardiovascular disease	14 (1.1)
Malignancy (radiotherapy)	14 (1.1)
Trauma	9 (0.7)
Acute coronary syndrome	1 (0.1)

Discussion

In our study the percentage of inpatients who received at least a single unit of RBCC transfusion was 1.41%. These patients were most frequently

Table 3. Percentage of hospitalizations with RBCC transfusions per hospital department

Hospital department	Hospitalization with RBCC [number (%)]	All hospitalizations [number (%)]	Percentage of hospitalizations with RBCC (%)
Gastroenterology &Hepatology	263 (20.0)	8290 (9.0)	3.2
Gynecology & Obstetrics	206 (15.7)	7117 (7.7)	2.9
Gastrointestinal Surgery	189 (14.4)	2661 (2.9)	7.1
Intensive Care Unit	170 (13.0)	381 (0.4)	44.6
Clinical Oncology	116 (8.8)	8904 (9.6)	1.3
Neurosurgery	93 (7.1)	3571 (3.9)	2.6
Autoimmune & Metabolic	79 (6.0)	1844 (2.0)	4.3
Clinical Pharmacology	61 (4.7)	1311 (1.4)	4.7
Neonatology	34 (2.6)	2212 (2.4)	1.5
Radiotherapy	32 (2.4)	1531 (1.7)	2.1
Stroke Unit	26 (2.0)	1141 (1.2)	2.3
Oncology	18 (1.4)	4501 (4.9)	0.4
Endocrinology & Neuroendocrine Tumors	8 (0.6)	3218 (3.5)	0.2
Neurology	8 (0.6)	3717 (4.0)	0.2
Oncological Surgery	5 (0.4)	1332 (1.4)	0.4
Neurological Rehabilitation	3 (0.2)	292 (0.3)	1.0
Adult Ophthalmology	1 (0.1)	31 633 (34.2)	0.0
Total	1312 (100)	92 532 (100)	1.4

Table 4. Number of RBCC units transfused during hospitalizations

Hospital department	Transfused RBCC [number (%)]	Hospitalizations with RBCC transfusion [number (%)]	RBCC per hospitalization [mean ± SD]
Gastroenterology & Hepatology	878 (22.0)	263 (20.0)	3.3 ± 3.3
Intensive Care Unit	647 (16.2)	170 (13.0)	4.0 ± 4.6
Gastrointestinal Surgery	633 (15.9)	189 (14.4)	3.2 ± 2.8
Gynecology & Obstetrics	591 (14.8)	206 (15.7)	2.8 ± 1.7
Clinical Oncology	283 (7.1)	116 (8.8)	2.5 ± 1.2
Neurosurgery	265 (6.6)	93 (7.1)	2.8 ± 2.4
Autoimmune & Metabolic	213 (5.3)	79 (6.0)	2.7 ± 1.4
Clinical Pharmacology	187 (4.7)	61 (4.7)	3.4 ± 2.9
Stroke Unit	75 (1.9)	26 (2.0)	2.9 ± 1.6
Radiotherapy	74 (1.8)	32 (2.4)	2.3 ± 0.5
Neonatology	45 (1.1)	34 (2.6)	1.3 ± 0.5
Oncology	42 (1.0)	18 (1.4)	2.3 ± 1.0
Neurology	22 (0.6)	8 (0.6)	2.8 ± 1.4
Endocrinology & Neuroendocrine Tumors	16 (0.4)	8 (0.6)	2.0 ± 0.0
Oncological Surgery	11 (0.3)	5 (0.4)	2.2 ± 1.1
Neurological Rehabilitation	7 (0.2)	3 (0.2)	2.3 ± 0.6
Adult Ophthalmology	2 (0.1)	1 (0.1)	2.0 ± 0.0
Total	3991 (100)	1312 (100)	3.1 ± 2.8

RBCC — packed red blood cells, SD — standard deviation

diagnosed with malignant tumor, non-gastrointestinal bleeding, gastrointestinal disease, gastrointestinal bleeding (Table 2). The percentage of RBCC-transfused inpatients in community-based Kaiser-Permanente database was as high as 13% [7]. The comprehensive data coming from the United States showed that 10.9% of inpatients received at least a single unit of RBCC [8]. The disparity with our study could be related to different mix of hospital departments, different hospital populations, and different periods of time analyzed. It is worth mentioning that in the study period the Regional Blood Transfusion Center supplied adequate amounts of RBCC so the low volumes of RBCC transfused could not be attributed to out--of-hospital reasons.

In the Dutch multicenter study PROTON (Profiles of Transfusion Recipients), covering inpatients from 20 hospitals in the period 1996–2006, patients who received RBCC transfusion were mostly diagnosed with neoplasms (22.2%), circulatory system disorders (21.5%), injury and poisonings (10.5%), digestive system disorders (9.8%), hematological disease (anemia, coagulation defects, purpura) (8.6%) [9, 10]. The primary diagnoses of patients who received the highest number of RBCC units were similar in our study (malignancy; non-oncologic gastrointestinal disease), although different classifications systems were used for disease categorization. In the study by Karafin et al., common primary diagnoses of transfused patients were blood diseases, infectious diseases, neoplasms, cardiovascular diseases, gastrointestinal disease and injury [8]. Primary diagnoses of neoplasm and gastrointestinal disease, as the main indication for transfusion, were in line with our study. Oncologic patients and patients with gastrointestinal diseases represented 44% of all RBCC recipients in our study. It is advisable to introduce causal treatment of anemia as RBCC transfusion may lead to significant complications. RBCC transfusion may be necessary if other measures are not effective. PBM efforts should be particularily focused on these two categories of patients. Avoiding RBCC transfusion is particularly important in oncologic patients as transfusion may potentially decrease chances of remission by affecting the patient's immune response, stimulating tumor growth, tethering, and dissemination [11]. On the other hand, patients with gastrointestinal disorders may bleed as a result of their primary diagnosis. Bleeding prophylaxis and timely management of bleeding eposodes is crucial for this population of patients.

In our study the mean number of RBCC transfused per hospitalization (if performed) was 3.1 ± 2.8 and varied between hospital departments. This number was higher than reported by American Association of Blood Banks (AABB), where the number of whole blood/RBC units per recipient was 2.72 [12].

Currently there is a tendency to use single unit RBCC transfusions as opposed to multiple unit RBCC transfusions in non-bleeding patients. In our study, 85.4% of all RBC transfusion were single unit transfusions. This may be explained by adherence of physicians to strict policy of RBCC transfusions or implementation of informal hospital campaigns promoting single unit RBCC transfusion. In one before-and-after study, single unit transfusion orders increased from 30–50% to 70–80% following education program [13]. The rationale behind single unit transfusion policy is to use the smallest effective dose of RBCC, so following first RBCC transfusion reassessment should be performed, taking into account not only Hb concentration but also symptoms of anemia [14]. Choosing Wisely Canada compaign for reduction of unnecessary tests and treatments in health care summarized evidence in favor of single unit RBCC transfusions as opposed to two unit RBCC transfusions and initiated an educational program. If implemented, the single unit RBCC transfusion policy showed reduction in utilization of RBCC in numerous clinical settings [15, 16].

The number of RBCC units transfused per patient in a ward is influenced by the clinical condition of patients at admission. Almost half of all ICU hospitalizations involved RBCC transfusion, which results from the fact, that critically ill patients are hospitalized there [17, 18].

The hospital departments responsible for using the highest number of RBCC units in our study were gastroenterology & hepatology (22%), ICU (16.2%), gastrointestinal surgery (15.9%), gynecology & obstetrics (14.8%) (Table 4). The report from AABB showed that medical disciplines using the highest number of RBCC units were general medicine (28.5%), surgery (different surgical specialties) (19.9%), hematology/oncology (19.2%), and ICU (12.5%) [12]. The differences between our study and AABB report may be due to our hospital structural organization (no hematology department). Nevertheless surgical specialties and ICU were common users of large numbers of RBCC in both analyses. In our hospital, surgical speciality departments and intensive care used together 53.8% of RBCC units. This points to the need for diag-

nosis and preoperative treatment of anemia. The following measures are recommended in the ICU and surgical departments in order to avoid anemia that requires RBCC transfusion. First, preoperative anemia should be timely diagnosed [19]. For timely diagnosis of etiology of anemia diagnostic algorithms may be followed [20, 21]. Timely diagnosis of preoperative anemia is particularily important if iron/vitamin supplementation is required, as it needs time to take effect. Another useful measure is saving the blood lost into operative field through application of intraoperative blood saving machines [22], or minimizing iatrogenic blood loss through application of arterial in-line blood conservation devices [23, 24]. The important element of ICU PBM is reduction in the number of ordered laboratory tests leading to iatrogenic blood loss and increased risk of anemia and its complications.

Study limitations

Our study has some limitations. Firstly, we did not consider factors that may have affected the decision to transfuse RBCC: clinical signs of anemia, course of the primary disease, etc. We did not analyze transfusions of other blood components (fresh frozen plasma, platelets, cryoprecipitate) at the time of RBCC transfusion. The hospital electronic health records did not provide information on anemia treatment, such as iron, vitamin B12 and/or folate supplementation, administration of erythropoiesis stimulating agents. We did not analyze Hb concentration, so we had no knowledge of the prevalence of preoperative anemia which could have resulted in higher demand for RBCC in the perioperative period.

Conclusions

The results show that more than half of RBCC recipients were patients with primary diagnosis of malignancy, non-malignant gastrointestinal disease, or gastrointestinal bleeding. RBCC units were most frequently transfused to patients hospitalized in the ICU. More than half of all RBCC units were transfused in the ICU and surgical departments. In the development phase of inpatient PBM program particular attention should be focused on the abovementioned groups of patients.

Conflict of interest: none declared

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