

Red blood cell transfusion and chemotherapy administration: a study of resource utilization

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Few studies have examined the overall cost and healthcare burden of red blood cell (RBC) transfusion in chemotherapy-induced anemia. We analyzed resource utilization by patients receiving RBC transfusion in a tertiary-care cancer center. The study was designed in two phases. The prospective phase recorded the mean chair time in 1,279 clinic encounters. The observed mean chair time for patients receiving one unit of RBCs was 109 ± 19 minutes and for chemotherapy administration was 119 ± 100 minutes. In the retrospective phase, 11,016 clinic visits were analyzed, of which 83% involved an active treatment session (chemotherapy/transfusion). A total of 171 patients received a total of 337 transfusions (656 RBC units). The outpatient transfusion threshold was a mean hemoglobin level of 76.5 ± 12.3 g/L, and on average 1.9 ± 0.3 units of blood were administered on each occasion. Transfusion requirements were the most intense and highest among patients with myelodysplastic syndromes/chronic myeloproliferative disorders and nonmalignant hematology patients. Based on our prospective chair-time data, an estimated 71,504 minutes were consumed by all RBC transfusions, constituting 5.4% of all outpatient clinic chair-time events. We found that RBC transfusion consumed a significant proportion of chair time, which could otherwise have been utilized for chemotherapy administration. Whether a greater application of transfusion alternatives (eg, erythropoiesis-stimulating agents) or dedicated transfusion clinics could reserve such facilities for their intended purposes, thus allowing the timely administration of chemotherapy and optimization of clinic resource utilization, needs further study.

Treatment-induced anemia is common in cancer patients, with an estimated prevalence ranging from 29% to 50% among patients receiving radiation therapy and chemotherapy. This anemia carries a high societal burden with costs related to inpatient care, anemia investigation, and decreased productivity.¹

Oncology patients are among the largest consumers of blood products after surgical patients.² Most oncology patients requiring red blood cell (RBC) support are transfused in outpatient chemotherapy suites or associated hospitals, as few cancer programs have dedicated blood transfusion facilities. These clinics experience large demands for resource allocation due to the high volume of patients requiring chemotherapy. Patients requiring blood transfusions compete for the same available health care resources as patients requiring chemotherapy, which may lead to delays in therapy in the already

overburdened outpatient clinic.

Alternatives to RBC transfusion are available, the most common of which are erythropoiesis-stimulating agents (ESAs). ESAs have been successfully used to treat chemotherapy-induced anemia (CIA) and have been shown to reduce the need for RBC transfusion as well as to improve quality of life.³⁻⁷

Established treatment guidelines by the American Society of Clinical Oncology (ASCO) and the

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American Society of Hematology (ASH) recommend the use of ESAs in the clinical management of CIA.⁸ Despite this recommendation, ESAs are not universally integrated into routine oncology practice in Canada, primarily due to their relatively higher acquisition costs compared with blood transfusion. This approach excludes the indirect costs associated with transfusion.

Few studies have examined the overall cost and healthcare burden of transfusion in CIA. Two studies have previously estimated the direct costs of RBC transfusion to be approximately \$500 per unit in US dollars,^{9,10} which includes the cost of testing, product preparation, infusion, and potential transfusion reactions and complications. Other costs to consider include the possibility of infectious disease transmission, which when accounted for leads to an average cost of \$786 per unit in 1999 Canadian dollars as reported by Dranitsaris.¹¹ A retrospective economic evaluation of RBC transfusion requirements among chemotherapy patients at the Princess Margaret Hospital in Toronto has reported the total cost per transfused patient to range from \$668 to \$1,271 in 1998 Canadian dollars, which included both direct and indirect costs to the system and patients.^{12,13} However, few studies have evaluated the concept of potential lost opportunities for chemotherapy administration when transfusions are administered in chemotherapy suites, thus creating conditions for competition for scarce resources such as “chair-time” and nursing attention.¹⁴

The objective of this study was to assess the “chair time” utilized by RBC transfusion compared with chemotherapy administration in a tertiary-care cancer center. This chair time was determined by direct observation and was defined as the amount of time spent by the patient in the chemotherapy suite while actively utilizing hospital resources, including nurs-

ing time and clinic space. We also characterized the patient population receiving RBC transfusion in terms of diagnosis, chemotherapy regimen, and use of ESAs.

Methods

We analyzed chair-time utilization at the London Regional Cancer Program (LRCP) in a patient population receiving RBC transfusion in a two-phase study design: (1) prospectively over a 4-week observation period and (2) retrospectively over 6 months. The LRCP is a tertiary-care out patient oncology referral program in southwestern Ontario, Canada, with a catchment area of approximately 2 million people. The chemotherapy suite is an outpatient facility within the LRCP that provides chemotherapy administration, blood product transfusion, and clinical care such as central line catheter maintenance. This research was approved by the University of Western Ontario's Institutional Ethics Review Board.

The first phase was a prospective study tracking all patients transfused in our clinic over a 4-week period to provide an accurate estimate of “chair-time” occupation by various clinical activities. Chair time was defined as the amount of time spent by the patient at the chemotherapy suite while actively utilizing hospital resources, including nursing time and clinic space. Data collected included average time required to receive chemotherapy, RBC transfusion, and “other” clinical interventions (ie, central line care). These data were collected by one of the investigators directly observing and timing each clinical event using a stopwatch.

The second phase of the study was a retrospective analysis of data from the LRCP electronic database, Oncology Patient Information System (OPIS), over 6 months (May to November 2005). All chemotherapy suite clinic visits were recorded on the electronic database. Data collected

for each visit included clinical activity (coded as chemotherapy administration, RBC transfusion, or other clinical care activities), chemotherapy regimen, number of RBC units transfused, patient's age, gender, diagnosis, pretransfusion hemoglobin level (Hb), and the use of ESA therapy among transfused patients. All data were extracted from OPIS except for data on the use of ESAs.

The use of ESAs was derived by manually reviewing the electronic charts of all transfused patients. If the treating physician had documented ever starting an ESA, the patient was considered to have received or potentially received an ESA at the time of study. RBC transfusions were verified by cross-referencing the OPIS electronic record with the blood bank's record of RBC units released to the clinic. The blood bank record was considered to be the most accurate, as it is part of a standard protocol to document all blood units issued to LRCP. In case of discrepancy, the blood bank data were used.

Using the prospective data on chair-time consumption for RBC transfusion and chemotherapy administration, we extrapolated the total chair time consumed by each of these activities over the 6-month retrospective chart review study period. The relative chair time consumed by RBC transfusion compared with chemotherapy administration was then calculated as a surrogate of opportunities that may potentially be lost for chemotherapy administration.

All statistical analyses were performed using Microsoft® Excel 2000, and summarized by descriptive statistics in means and standard deviations (SD).

Results

Prospective chair-time study

A total of 1,354 visits to the chemotherapy suite were captured over the 4-week study period. Of them,

TABLE 1

Prospective chair-time study: summary of chair-time utilization by clinical activity

Clinical activity	Number of visits (n = 1,279)	Percentage of visits, %	Time, min (mean ± SD)
Chemotherapy	1,023	80.0	119 ± 100
RBC transfusion (2 units) ^a	44	3.4	231 ± 47
Other	212	16.6	33 ± 43

SD = standard deviation; RBC = red blood cell

^a The mean number of units per transfusion was 2.2, with most patients receiving 2 units. The mean chair time per unit of blood was 109 ± 19 minutes. Due to additional nursing and clerical time, administration of 2 units of blood required slightly longer than double the time for 1 unit.

TABLE 2

Six-month retrospective chart review analysis: demographics of the study population

Demographic variable	Number	Percent
Total number of clinic visits	11,016	
Total number of patients	2,478	
Number of patient visits involving active treatment (ie, chair-time utilization for chemotherapy or transfusion)		
Yes	9,173	83.3
No/missing ^a	1,843	16.7
Number of patients with a dual diagnosis	15	0.1
Solid tumors	1,985	80.1
Breast cancer	742	29.9
Genitourinary/gynecologic cancer	416	16.8
Gastrointestinal cancer	359	14.5
Lung cancer	201	8.1
Other	267	10.8
Malignant hematologic disease	402	16.2
Lymphoma	161	6.5
Multiple myeloma	125	5.0
Chronic lymphocytic leukemia	37	1.5
Chronic myeloproliferative disease/myelodysplastic syndromes/myelofibrosis	23	0.9
Lymphoproliferative disorder (unclassified)	12	0.5
Acute lymphocytic leukemia	10	0.4
Hodgkin's lymphoma	8	0.3
Acute myeloid leukemia	7	0.3
Waldenström's macroglobulinemia	4	0.2
Hairy cell leukemia	2	0.1
Other	13	0.5
Nonmalignant hematologic disease	48	1.9

^a These are visits that were not listed as chemotherapy administration or transfusion. They may include other activities, such as central line care or phlebotomy, and possibly may include transfusions that were not documented in the database.

1,279 (94.5%) visits from 716 patients were evaluable. Table 1 describes the number of visits and chair time consumed by chemotherapy ad-

ministration, RBC transfusion, and "other" activities (including central line care, phlebotomy, etc). Although chemotherapy administration ac-

counts for the vast majority of visits, the mean chair time per visit for RBC transfusion is approximately two-fold greater.

Retrospective chart review

A total of 11,016 clinic visits by 2,478 patients were analyzed over a 6-month study period, and the demographic data for this population are summarized in Table 2. The majority of the patients were being treated for solid tumors with the most common diagnoses being breast, genitourinary/gynecologic, and gastrointestinal malignancies. Hematology patients constituted the minority study population.

Table 3 provides data on patients who received transfusions in terms of demographics, diagnoses, incidence and intensity of transfusion, as well as transfusion threshold. Although the majority of the patients seen in the chemotherapy suite had solid tumors (80%), a disproportionate amount of blood (41%) was consumed by patients with hematologic diseases, which represented only 18% of the study population. The transfusion threshold in this outpatient facility was at Hb levels of < 80 g/L. Approximately two-thirds of the transfused patients underwent one transfusion episode and an average of 1.9 units was transfused per episode.

Transfusion requirements were the most intense (mean number of transfusion episodes per transfused patients = 5.3 ± 3.4) and highest (mean number of units per transfused patients = 10.4 ± 6.5) among patients (n = 13) experiencing myelodysplastic syndromes (MDS)/chronic myeloproliferative disorders (MPD) and nonmalignant hematology patients (n = 4; mean number of transfusion episodes per transfused patients = 6.0 ± 6.2; mean number of units per transfused patient = 12.0 ± 11.7). Almost all solid tumor patients (94%) were on

active treatment for their primary diagnoses, whereas only 65% of the hematology patients were receiving active treatment.

Of all the transfused patients, only a relatively small number were treated with an ESA, as captured by the electronic record documenting initiation of ESA therapy by the treating physician. The majority of these patients were being treated for solid tumors. We were not able to determine whether the transfused patients were previous recipients of ESA therapy or whether ESA therapy was planned for the future.

Although transfusion accounted for only 3% of all events (337 transfusion events of 11,016 patient visits), this intervention was a relatively high consumer of chair time, accounting for 5% of all LRCP outpatient clinic chair time that could potentially have been used for chemotherapy administration. Table 4 outlines the method for extrapolating the proportion of chair time used by transfusion compared with chemotherapy administration. In terms of transfusion chair/nursing resource utilization, this is estimated to be equivalent to approximately 600 average chemotherapy administration events over 6 months and an estimated 1 to 1.25 full-time nursing equivalents per year (based on a nursing full-time equivalent of 1,950 hours per year and an estimated 2,384 hours consumed by RBC transfusion per year).¹⁵

Discussion

RBC transfusion accounted for 3% of all clinical events and consumes 5% of all available chemotherapy chair time at the LRCP. Using prospective and retrospective analyses, we identified 337 transfusion episodes and 656 units of blood delivered to 171 patients over 6 months. A large proportion of the transfused patients had hematologic diseases (41%), despite the fact that they comprised less than 20% of the cancer population seen at

our center. Transfusion requirements were the most intense and highest among patients with MDS/chronic MPD (mean number of transfusion episodes per transfused patient = 5.3; mean number of units per transfused patient = 10.4).

To our knowledge, the only other study that has attempted to evaluate the time burden of blood transfusion in an oncology clinic was conducted by Ueno and colleagues.¹⁴ In retrospective and prospective studies of 100 transfusion visits by 36 patients, the authors similarly reported that the majority of transfusions were administered to MDS patients (59%) or to those who experienced CIA (22%), with an average of 2 units of RBCs being transfused on each occasion. The average total time spent per unit transfused was 103 ± 18.6 minutes, essentially identical to the transfusion chair time of 109 ± 19 minutes per unit reported here. In addition, these authors attempted to quantify the labor time involved in the administration of RBC transfusions and reported an additional 67 minutes of labor per transfusion episode attributed primarily to nursing activities.^{14,16}

The chair time required for transfusion competes for chemotherapy administration or related clinical interventions. In our cancer center and similarly structured institutions, intense competition between transfusions and chemotherapy administration can be inferred from a number of factors. We prospectively identified in the first phase of this study that chemotherapy protocols com-

TABLE 3

Summary of clinical variables for transfused patients

Clinical variable	Number (%)
Total transfused patients	171 (100)
Male	91 (53.2)
Female	80 (46.8)
Erythropoietic agent	19 (11.1)
Epoetin alfa	18 (10.5)
Darbepoetin alfa	1 (0.6)
Disease subgroup	
Solid tumor	93 (54.4)
Genitourinary cancer	22 (12.9)
Lung cancer	20 (11.7)
Gastrointestinal cancer	18 (10.5)
Breast cancer	18 (10.5)
Gynecologic cancer	15 (8.8)
Hematologic	70 (40.9)
Malignant	66 (38.6)
Nonmalignant	4 (2.3)
Other	7 (4.1)
Number of transfusion episodes	337
Number of units transfused	656
Units per transfusion, mean \pm SD	1.9 ± 0.3
Number of transfusion episodes per patient	
1	115 (67.3)
2–4	41 (24.0)
5 or more	15 (8.8)
Pretransfusion hemoglobin level, g/L	
Mean \pm SD	76.5 ± 12.3
Range	37.0–106.0

SD = standard deviation

monly administered to patients with gynecologic cancers (platinum based) and lymphoma (such as combination regimens containing rituxumab

TABLE 4

Extrapolated proportion of time utilized by RBC transfusion compared with chemotherapy administration

	Number of events	Time per unit (min)	Total time (h)	Proportion of chair time consumed by RBC transfusion
RBC units	656	109	1,191.7	5.4%
Chemotherapy administration	9,173	119	18,193.1	–

RBC = red blood cell

[Rituxan]) at the LRCP are the most chair-time intensive treatments (median duration of 3–4 hours, up to 7–8 hours; data not shown). RBC transfusion is then the next longest treatment protocol after these chemotherapy regimens, at a duration of 4–5 hours for a standard two-unit transfusion. Given that patients with gynecologic cancer and those with lymphoma accounted for a significant proportion of the patient population who receive care at the LRCP, an intense competition for chair time and nursing resources between transfusion and chemotherapy administration could be anticipated. Another indicator of intense resource competition was that a significant number of transfusions took place in “overflow” stretcher beds rather than in clinic chairs (7% of all transfusions), suggesting that the chemotherapy suite is already operating at or beyond peak capacity. As a result, we can extrapolate that treatment delays are likely to have occurred under such a resource-limiting environment.

A potential solution to the competition for chair time between transfusion and chemotherapy would be the use of a dedicated transfusion clinic, thus allowing the use of the chemotherapy suite exclusively for drug delivery. Other methods to reduce transfusion burden would be to employ blood-conservation strategies, such as the observation of appropriate transfusion thresholds and the use of ESAs in eligible patients. The mean transfusion trigger at the LRCP was 76.5 ± 12.3 g/L, a relatively conservative threshold for outpatients who could be suffering from chronic symptomatic anemia; this threshold suggests that it would be unlikely to avoid transfusion events by further reducing the current transfusion threshold.

ESAs appear to be minimally utilized in our study, with only 11% of the transfused patients receiving these agents. One potential explanation is

that hematology patients constituted 18% of the total study population but a large proportion of the total transfused population (41%). Among patients with hematologic disease, 34 of 70 had a diagnosis of acute myeloid leukemia, acute lymphoblastic leukemia, MDS, and chronic MPD, conditions in which ESAs are usually not indicated. Similarly, Ueno et al noted that 59% of transfused patients in their study had MDS.¹⁶

It is recognized that patients with chronic myeloproliferative disease/MDS are less likely to benefit from ESA therapy. Response rates to ESAs in patients with MDS range from 20%–25%,¹⁷ compared with CIA in solid tumors, which demonstrates significantly higher response rates (ranging from 24%–75%).¹⁸ Therefore, ESA therapy would be expected to benefit mainly the solid tumor population with normal bone marrow function and CIA. However, on average, these patients only required one transfusion (mean number of transfusions per transfused patient = 1.1). Our results suggest that for solid tumors, ESA therapy would best be applied on a prophylactic basis using an algorithmic approach (ie, starting ESA therapy when the Hb level drops below a prespecified threshold) rather than by starting it after a transfusion event, because few patients will require multiple transfusions. Given our study population, it is unlikely that the use of ESAs would have significantly reduced chair time consumption by RBC transfusion because of the high proportion of patients with non-ESA-responsive hematologic conditions.

Conclusion

We determined that RBC transfusion consumes 5% of the total available chemotherapy chair time and associated nursing resources at an outpatient tertiary-care cancer clinic. The concept of chair-time utilization may be a better indica-

tor of the true costs of RBC transfusion and demonstrates the idea of opportunity lost, which is frequently overlooked in the current literature. Transfusion alternatives, such as the use of ESAs, are of potential use to limit chair-time utilization, but their benefit depends on the target patient population and the case mix at a particular cancer center.

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