BMC Emergency Medicine

RESEARCH

Open Access

In-hospital stay of anemic patients in the ED with/without transfusion: a single-center propensity-matched study

Fabien Coisy[1*], Clémence Anselme[2], Radjiv Goulabchand[3], Laura Grau-Mercier[1], Thibaut Markarian[4], Xavier Bobbia[5] and Romain Genre-Grandpierre[1]

Abstract

Background Anemia affects up to 25% of emergency department (ED) patients. Restrictive red blood cell (RBC) transfusion strategies are recommended for stable patients, but ED transfusion practices often remain liberal. Benefits of ED transfusion remains unclear.

Objective To evaluate the impact of ED transfusion on death-adjusted in-hospital length of stay (LOS) in stable anemic patients requiring hospitalization.

Methods This single-center retrospective propensity-matched study included patients ≥ 18 years admitted to the ED of Nîmes University Hospital in 2022 with hemoglobin levels between 70 and 90 $g.L^{-1}$. Patients with hemorrhagic shock or requiring emergent hemostatic procedures were excluded. Propensity score matching was conducted on variables including age, comorbidities, hemoglobin levels, and diastolic blood pressure. Primary outcome was adjusted in-hospital LOS. Secondary outcomes included ED LOS and RBC transfusion volumes.

Results Among 564 patients, 118 (21%) were propensity-matched: 59 (50%) ED-transfused, 59 (50%) non-ED-transfused. Adjusted in-hospital LOS 13 [8–32] for ED-transfused patients and 12 [6–24] days for non-ED-transfused patients (median difference = 0; 95%CI: -10–7; $p = 0.52$). Median difference in ED LOS was 7:13 (95%CI: 1:00–11:25; $p < 0.001$) between ED transfused and non-ED-transfused patients. Median difference in number of RBC transfused during in hospital stay was 2 (95%CI: 1–3); $p < 0.01$) between ED transfused and non-ED-transfused patients.

Conclusion In stable anemic patients with 70 to 90 $g.L^{-1}$ hemoglobin level, ED transfusion did not reduce adjusted in-hospital LOS but prolonged ED LOS. Identifying patients who may safely defer transfusion could improve ED efficiency and safety.

Keywords Blood transfusion, Length of stay, Anemia, Emergency Department, Hospital

*Correspondence:
Fabien Coisy
fabien.coisy@gmail.com
[1]UR UM 103 (IMAGINE), Department of Emergency Medicine, CHU Nîmes, University of Montpellier, Nîmes, France4 rue du Pr Robert Debré, 30900
[2]Department of Emergency Medicine, CHU Nimes, Nîmes, France
[3]IDESP, INSERM, Department of Internal Medicine, CHU Nîmes, University of Montpellier, Nîmes, France
[4]Department of Emergency Medicine, Timone University Hospital, Marseille, France
[5]UR UM 103 (IMAGINE), Department of Emergency Medicine, Montpellier University Hospital, Montpellier University, Montpellier, France

Introduction

Anemia, defined by the World Health Organization as a hemoglobin level below 120 $g.L^{-1}$ for women and 130 $g.L^{-1}$ for men, is a worldwide problem [1]. Anemia worsens the prognosis of several diseases such as heart failure and can increase in-hospital length of stay (LOS) [2, 3]. Symptoms of anemia are nonspecific, and many patients may be asymptomatic [4]. The fastest therapeutic response to symptomatic anemia is packed red blood cell (RBC) transfusion. Current recommendations advocate a restrictive transfusion strategy, i.e., no transfusion above a hemoglobin threshold of 70 $g.L^{-1}$ in hemodynamically stable patients, with moderate certainty of evidence [5, 6].

In the emergency department (ED), 12 to 25% of admitted patients may present with anemia [7, 8]. The proportion of patients with symptomatic anemia in the ED remains unclear, because patients often present with complex illnesses with overlapping symptoms such as fatigue, dyspnea, or tachycardia [5]. Reports suggest over-transfusion strategies in the ED, especially for patients with hemoglobin levels around 80 $g.L^{-1}$ [9]. A multicenter French study found that 20% of patients were overtransfused in the ED [10]. Blood transfusions in the ED could account for up to 10% of hospital transfusions annually [11], while 20 to 40% may be inappropriate [12]. Finally, the reasons for transfusion in the ED in patients without hemodynamic instability seem unclear.

No study in a high-income country has shown a benefit of transfusion in the ED for patients with anemia and no life-threatening condition. We hypothesized that transfusion of hemodynamically stable patients requiring hospitalization, admitted to the ED with anemia between 70 and 90 $g.L^{-1}$ would alter in-hospital LOS. We sought to determine whether there was a difference in death-adjusted in-hospital LOS of patients with a hemoglobin level between 70 and 90 $g.L^{-1}$, using a propensity score to assess the impact of receiving a transfusion in the ED or not.

Methods

Study settings

This study was a propensity-matched retrospective single-center study conducted at the university hospital of Nîmes, France between January 1st and December 31st, 2022. This ED received 119 301 patients in 2022. The local ethics committee of Nimes' university hospital approved the study (IRB 23.05.02). A nonobjection letter was sent to patients or their relatives if patients died during hospitalization, explaining the aims of the study and the possibility of refusing data collection. Data were collected from May 30th, 2023, to September 30^{tht} 2023. The authors had access to information that could identify individual participants during data collection, which was not collected. This study is reported following the strengthening of reporting of observational studies in epidemiology for propensity-matched cohort guidelines [13].

Population

The study population included ≥ 18-year-old patients who presented to the ED with a biological diagnosis of anemia, characterized by hemoglobin levels between 70 and 90 $g.L^{-1}$, and who were subsequently hospitalized, regardless of the reason for hospitalization. Patients were clinically stable. Patients with hemorrhagic shock, defined as acute external or internal blood loss associated with hemodynamic failure and hyperlactatemia greater than 2 $mmol.L^{-1}$ of traumatic or nontraumatic origin, were not included. Patients requiring emergency hemostatic procedures (surgical intervention, radiologic or endoscopic procedures to stop an acute bleeding), and pregnant women, were excluded. Patients returning home after ED admission were excluded. Finally, only the first admission was analyzed in patients with multiple ED visits for anemia.

Objectives

The primary outcome was the difference in adjusted-LOS between patients presenting to the ED with anemia between 70 and 90 $g.L^{-1}$ who were transfused in the ED and those who were not. In-hospital LOS was measured in days, as the time between ED admission and hospital discharge date. Adjustment for mortality was made by imputing maximum in-hospital LOS for patients who died in the hospital. Secondary outcomes were the ED LOS (including total time in hours, boarding and time spent more than 1 day in the ED), number of RBC transfused in the ward and total hospital stay. We also aimed to compare the adjusted in-hospital LOS according to the number of RBC transfused (0, ≤ 2 and 3 ≤) in the ED, on the ward and during whole the in-hospital stay.

Data collection

Patients were screened using the list of initial biological results of ED patients, provided by the hospital's hematology laboratory. Data were collected retrospectively from patients' electronic ED files by individual chart review by a single investigator using a predefined questionnaire. In case of doubt, a second investigator reviewed the chart. For quality assessment, files with abnormal values during statistical analysis were reviewed and corrections were made if there were an error. If data were outliers in the chart, they were excluded.

Data collected included: age, sex, reason for visit, arterial blood pressure, heart rate, oxygen saturation, and Charlson's comorbidity index. Symptoms of anemia were defined by the presence of asthenia, dyspnea, chest pain,

dizziness, syncope or blood loss among the causes of ED admission. Initial ED biological results were collected: hemoglobin level, mean corpuscular volume, platelet count and leukocyte count. The presence of RBC transfusion and the number of RBC units transfused in the ED were also collected. Total ED LOS was collected and defined as the time between ED admission and ED discharge. Boarding, defined by "holding admitted patients in the ED, in hallways, while awaiting an inpatient bed", was recorded as an informatic transfer in the hospitalization waiting zone [14]. Patients transfused in the hospitalization waiting zone were considered to have been on the ward, as they would not have remained in the ED if a bed had been available. Patients whose transfusion was started in the ED and who were admitted during the transfusion were included in the ED-transfused group. Hospital admission was recorded and categorized as general inpatient unit or intensive care unit (ICU). The final ED diagnosis was categorized into 11 modalities (cardiovascular, neurologic, urologic and digestive, hematologic, bleeding, respiratory, metabolic, infectious, traumatic, general symptoms and others). Bleeding included any type of bleeding, including gastrointestinal, wound, epistaxis, hemoptysis or hematuria. General symptoms included general deterioration, fatigue and falls. In-hospital death was ascertained from electronic medical records.

Statistical analysis

Missing data were imputed using a linear regression model for hemodynamic parameters if the number of missing values was less than 25% of the total sample size. There were no missing data for in-hospital LOS,. Qualitative variables were expressed as absolute values and percentages. Quantitative variables were expressed as median with the first and third quartiles.

To reduce confounding bias and improve comparability between transfused and non-transfused patients, propensity score matching was performed. Logistic regression analysis was first performed to identify relevant factors for inclusion in the propensity score model. Variables were selected for inclusion if they showed an association with the outcome variable in univariate analysis with a p-value < 0.2. Adjustment was realized to minimize the Akaike's information criteria. The final logistic regression model included the following covariates: age, history of myocardial infarction, chronic obstructive pulmonary disease, platelet count, mean corpuscular volume, history of recent external bleeding, history of falls, diastolic blood pressure, and hemoglobin level. This regression model allowed the calculation of a propensity score for each patient, representing the probability of receiving a transfusion based on these covariates. Patients were then matched based on the propensity score using a nearest neighbor matching algorithm with a 1:1 ratio and a caliper of 0.01 to minimize differences in propensity scores between pairs. Between-group balance was assessed by comparing standardized mean differences for each covariate, with a threshold set at 0.1 (10%) for acceptable balance. Additional balance checks included variance ratios and cumulative distribution differences. This matched sample was then used for secondary analyses, using statistical tests appropriate for matched data to compare outcomes between groups. Specifically, logistic regression was used to analyze quantitative, while paired Wilcoxon tests were applied for quantitative variables. For quantitative variables, median differences and 95% confidence intervals (95% CI) were calculated using the bootstrap method with a sample size of 1000. Odds ratios (OR) and their 95% CIs were calculated by logistic regression for both qualitative and quantitative variables. All tests used were two-tailed with significance set at 5%. As this was an exploratory study, no sample size was calculated. Data were analyzed and plots were performed using R software, version 4.4.0. (R Core Team (2022). R: A language and environment for statistical computing. R Foundation for Statistical Computing, Vienna, Austria), associated with the MatchIt package.

Results

From January 1st to December 31st, 2022, 11 208 (9%) had anemia with less than 120 $g.L^{-1}$. A total of 1 169 (10%) patients having anemia between 70 and 90 $g.L^{-1}$ were screened, of which 569 (49%) were excluded: 390 (69%) patients were not hospitalized after ED admission and 55 (10%) had missing data (Fig. 1). A total of 564 (48%) unique patients with anemia between 70 and 90 $g.L^{-1}$ were analyzed. The median age of the population was 77 [68; 85] years old, and 240 (43%) were female. The median hemoglobin level on admission to the ED was 83 [78; 87] $g.L^{-1}$. A total of 127 (23%) patients received RBC transfusion in the ED.

After propensity matching, 59/437 (14%) and 59/127 (46%) patients remained in each group. The standardized mean differences for covariates were all less than 0.1, and the variance ratios were close to 1. The empirical cumulative distribution function after propensity matching ranged from 0.03 to 0.1. Details of the propensity score matching are provided in Supplemental material (Table S1, Table S2 and Figure S1). In the matched cohort, the median age was of 75 [68; 84] years old and 77 [68; 85] years old and women were 21 (36%) and 25 (43%) in the non-ED transfused and ED-transfused groups, respectively. Patients presenting with chest pain at ED admission were 4 (7%) in the non-ED transfused group and 0 (0%) in the ED transfused group. Baseline patient characteristics before and after propensity matching are shown in Table 1.

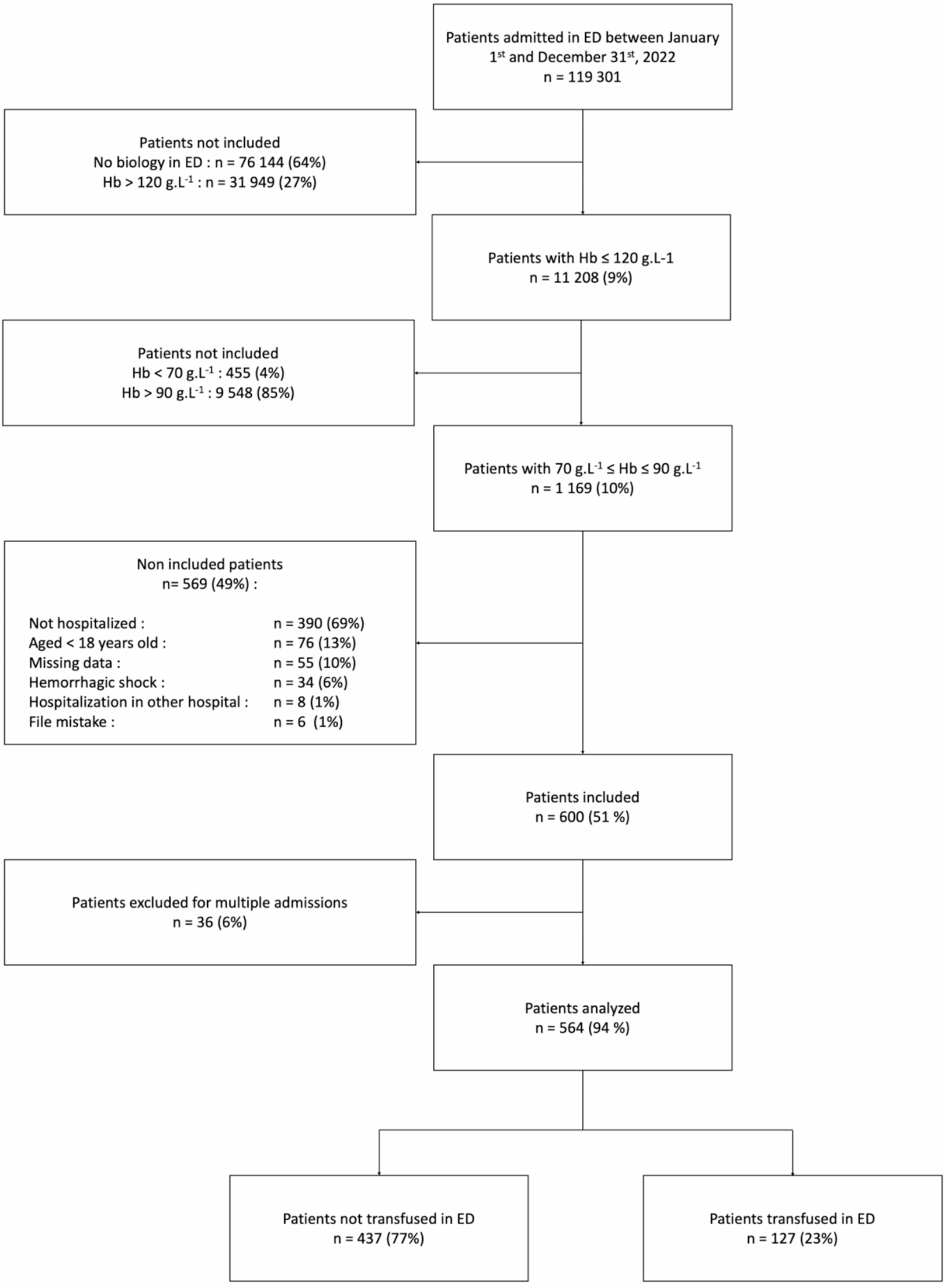

Fig. 1 Flow chart
ED: Emergency department, Hb: hemoglobin

Table 1 Characteristics of the global study population and propensity matched cohort, regarding the transfusion in emergency department

	Unmatched cohort		Propensity matched cohort	
Variables	**Non-ED transfused patients *n* = 437**	**ED transfused patients *n* = 127**	**Non-ED transfused patients *n* = 59**	**ED transfused patients *n* = 59**
Demographics				
Age in years, m [Q1; Q3]	76 [67; 86]	78 [70; 84]	75 [69; 84]	77 [68; 85]
Sex, women, n(%)	189 (43)	51 (40)	21 (36)	25 (43)
Medical history				
Charlson comorbidity index, m [Q1; Q3]	4 [2; 6]	4 [2; 6]	4 [2; 7]	4 [1; 6]
Myocardial infarction, n(%)	74 (17)	38 (30)	19 (32)	17 (29)
Chronic heart failure, n(%)	37 (8)	14 (11)	8 (14)	4 (7)
Chronic obstructive pulmonary disease, n(%)	55 (13)	29 (23)	8 (14)	9 (15)
Chronic kidney disease, n(%)	165 (38)	46 (36)	26 (44)	21 (36)
Chronic anemia, n(%)	298 (68)	62 (49)	35 (59)	31 (53)
Symptoms reported at ED admission				
Fatigue, n(%)	102 (23)	36 (28)	11 (19)	16 (27)
Dyspnea, n(%)	99 (23)	29 (23)	13 (22)	13 (22)
Recent external blood loss, n(%)	55 (13)	62 (49)	18 (31)	21 (36)
Fall, n(%)	54 (12)	6 (5)	3 (5)	5 (8)
Chest pain, n(%)	24 (5)	1 (1)	4 (7)	0 (0)
Syncope, n(%)	11 (3)	3 (2)	4 (7)	0 (0)
Dizziness, n(%)	2 (0)	2 (2)	-	-
Vital parameters				
Systolic blood pressure in mmHg, m [Q1; Q3]	126 [114; 140]	121 [105; 132]	126 [110; 134]	123 [107; 135]
Diastolic blood pressure in mmHg, m [Q1; Q3]	67 [60; 75]	62 [53; 70]	67 [59; 75]	66 [58; 74]
Heart rate in beats per minute, m [Q1; Q3]	89 [82; 100]	89 [75; 99]	88 [81; 97]	90 [76; 101]
Oxygen saturation in %, m [Q1; Q3]	97 [96; 98]	97 [96; 98]	97 [95; 98]	98 [96; 99]
Biological parameters				
Hemoglobin in $g.L^{-1}$, m [Q1; Q3]	84 [80; 88]	77 [73; 83]	80 [75; 84]	81 [74; 85]
MCV in fL, m [Q1; Q3]	92 [86; 99]	95 [88; 100]	93 [89; 98]	93 [88; 98]
Platelets in $G.L^{-1}$, m [Q1; Q3]	226 [135; 344]	254 [177; 330]	261 [146; 368]	250 [171; 328]
Leukocytes in $G.L^{-1}$, m [Q1; Q3]	9.4 [6.0; 13.6]	9.6 [6.8; 12.8]	8.7 [5.3; 12.7]	10.0 [7.2; 15,0]
ED final diagnostic				
General symptoms	69 (16)	15 (12)	8 (14)	8 (14)
Neurologic	13 (3)	0 (0)	-	-
Cardiovascular	34 (8)	9 (7)	4 (7)	3 (5)
Respiratory	25 (6)	5 (4)	4 (7)	1 (2)
Metabolic	37 (9)	4 (3)	7 (12)	3 (5)
Infection	76 (18)	12 (10)	7 (12)	6 (10)
Bleeding	24 (6)	34 (27)	7 (12)	15 (25)
Trauma	40 (9)	5 (4)	5 (8)	3 (5)
Urologic and digestive	36 (8)	16 (13)	4 (7)	8 (14)
Hematologic	22 (5)	18 (14)	6 (10)	7 (12)
Others	55 (13)	8 (6)	7 (12)	5 (8)
Hospitalization ward				
General inpatient unit, n(%)	52 (89)	112 (88)	52 (88)	52 (88)
Intensive care unit, n(%)	50 (11)	15 (12)	7 (12)	7 (12)

ED: emergency department, MCV: mean corpuscular volume

General symptoms included general deterioration, fatigue and falls

Table 2 Primary and secondary outcomes for the propensity matched cohort

	Non-ED transfused *n* = 59	ED transfused *n* = 59	Median difference (95%CI)	Odds Ratio (95%CI)	*p*-value
Primary outcome					
Adjusted in-hospital LOS in days, m [Q1; Q3]	12 [6; 24]	13 [8; 32]	0 (-10–7)	1.00 (0.99–1.02)	0.52
Secondary outcomes					
ED LOS in hh: mm, m [Q1; Q3]	11:38 [5:53; 18:35]	18:51 [10:56; 24:51]	7:13 (1:00–11:25)	1.04 (1.00–1.08)	< 0.001
Boarding, n(%)	13 (30)	31 (70)	-	3.92 (1.79–8.95)	< 0.001
More than 1 day stay in ED, n(%)	7 (32)	15 (68)	-	2.44 (0.94–6.88)	0.08
Transfusion in ward, n(%)	40 (58)	29 (42)	-	0.46 (0.21–0.96)	0.04
Number of RBC units transfused in ward, m [Q1; Q3]	2 [1;3]	2 [2;4]	0 (0–1)	1.16 (0.96–1.52)	0.15
Total number of RBC units transfused, m [Q1; Q3]	2 [1; 3]	4 [3; 5]	2 (1–3)	1.71 (1.26–2.44)	0.01
In hospital death, n(%)	10 (48)	11 (52)		0.83 (0.25–2.78)	0.81

95%CI: 95% confidence interval, ED: emergency department

Adjustment for length of stay consisted in imputing maximal in-hospital length of stay for in-hospital dead patients

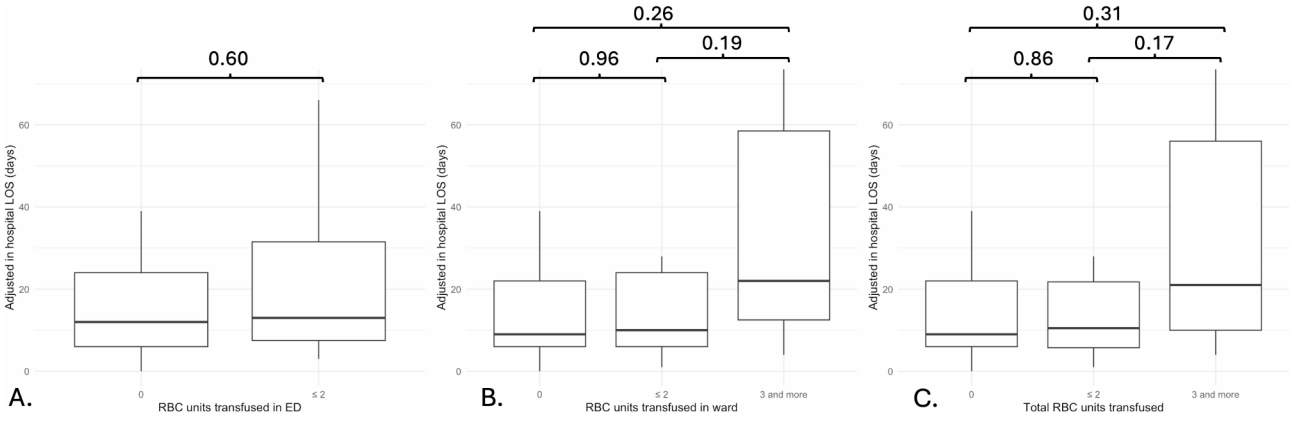

Fig. 2 Comparison of adjusted in-hospital length of stay according to number of units and place of transfusion in the propensity-matched cohort (*n* = 118 patients): (**A**) in emergency department, (**B**) in ward, (**C**) during total in-hospital stay. LOS: length of stay, ED: Emergency department, RBC: red blood cell
Adjustment for length of stay consisted in imputing maximal in-hospital length of stay for in-hospital dead patients

Adjusted in-hospital LOS was 12 [6; 24] days in the non-ED transfused group and 13 [8;32] days in the ED-transfused group (median difference = 0 (95%CI: -10–7), OR = 1.00 (95%CI: 0.99–1.02), $p = 0.52$). ED LOS was 11:38 [5:53; 18:35] and 18:51 [10:56; 24:51] for non-ED transfused and ED-transfused patients respectively (median difference = 7:13 (95%CI: 1:00–11:25), OR = 1.04 (95%CI: 1.00–1.08), $p < 0.001$). Results for the primary and secondary outcomes are shown in Table 2.

Comparison of adjusted in-hospital LOS according to the number of RBC transfused in the ED, on the ward and during the entire hospital stay is shown in Fig. 2.A, 2.B and 2.C respectively.

Discussion

Among ED patients with a hemoglobin level between 70 and 90 $g.L^{-1}$ with non-life-threatening emergencies, there was no difference in adjusted in-hospital LOS between patients transfused or not transfused in the ED (median difference = 0 (95%CI: -10–7), $p = 0.52$). Patients transfused in the ED were more likely to experience boarding than non-ED transfused patients (OR = 3.92, (95%CI: 1.79–8.95), $p < 0.001$), with a longer ED LOS (median difference = 7:13 (95%CI: 1:00–11:25), OR = 1.04 (95%CI: 1.00–1.08), $p < 0.001$). There was no significant difference in adjusted in-hospital LOS according to the number of RBC units transfused in the ED, on the ward and during the entire hospital stay.

The present study emphasizes that the hemoglobin level alone, indicating moderate anemia (≥ 70 g. dL^{-1}) in the ED should not be the sole consideration, and that even in symptomatic patients, transfusion may be delayed if hospitalization is required. Few studies have focused on patient outcomes after RBC transfusion in the ED. A Rwandan study found that transfusing patients in the ED increased mortality and in-hospital LOS [15]. However, the patients included were younger, hemoglobin admission was lower and blood safety procedures differ between Europe and Africa, so the risk of transfusion-related adverse events may be different [16].

A study, in 12 metropolitan hospitals in France, found that acute bleeding, history of ischemic cardiopathy and older age were associated with a pre-transfusion hemoglobin level of 80 $g.L^{-1}$ [10]. In the present study, transfused patients in the unmatched cohort, appeared to be older, had more history of ischemic cardiopathy. In the aforementioned study, the in-hospital LOS was 4 days [10]. The difference in hospital LOS in the present study could be explained by an older and sicker population, and a higher rate of ICU admission rate than in other studies [17, 18]. Dharmarajan et al. found that anemia increased LOS more in men than in women [19]. We did not find such differences in ED transfusion practice with respect to patient sex. A 2018 study found that the in-hospital LOS for patients with anemia was 11 days [3]. This study found that anemia severity was associated with in-hospital LOS, but no data on RBC transfusion were available.

Patients transfused in the ED were more likely to experience boarding and longer ED LOS. Although the design of our study cannot determine whether transfusion is a cause or a consequence of boarding, it is reasonable to assume that transfusion in the ED increases ED LOS. RBC transfusion requires a dedicated nurse for at least the first 15 min, and regular monitoring for 1 to 2 h [20]. In the ED, monitoring may be impractical for nurses caring for multiple patients of varying acuity. Therefore, patients transfused in the ED may result in a higher workload for physicians and nurses. There is a greater risk of incorrect blood in the tube in the ED than in the ward, and a higher risk of transfusion-related adverse events [21, 22]. This increased workload may contribute to higher in-hospital morbidity and mortality in patients with prolonged ED stays requiring hospitalization [23]. The potential benefit of ED transfusion on in-hospital LOS may therefore be masked by boarding.

Patients with a history of ischemic cardiomyopathy had higher rates of ED transfusion in the present study. However, recent studies have shown that even in patients presenting with acute coronary syndrome, a restrictive strategy does not worsen prognosis [24]. Symptoms of anemia tolerance are nonspecific and can be confused with other conditions. Beverina et al. found in 2019 that patients with moderate or severe anemia had the same proportion of symptoms and history of recent bleeding of around 30% [8]. They also found that almost 50% of patients with hemoglobin between 70 and 90 $d.dL^{-1}$ were transfused. In the present study, only 127/564 (23%) received RBC transfusion in the ED. This difference may be due to improvements in transfusion strategies or to geographic differences in transfusion habits [25]. Finally, the development of a patient blood management network in the ED, including alternatives to RBC transfusion [7, 8], education of nurses and physicians [26], and inter-hospital benchmarking could lead to further reductions in the proportion of patients in the ED transfused without life-threatening conditions [27]. However, a remaining challenge is to identify which patients should receive RBC transfusion in the ED. Low diastolic blood pressure may be associated with a poor tolerance of anemia [28]. Although our data seem to support this hypothesis, with patients in the ED transfused group having lower diastolic blood pressure than non-ED transfused patients (62 [53;70] vs. 67 [60;75] mmHg), prospective studies are needed to confirm this hypothesis. Microcirculation assessment may help identify patients with poor anemia tolerance. In the ICU, microcirculatory monitoring before and after RBC transfusion seems promising to determine which patients could benefit more from RBC transfusion [29].

We found a trend toward longer adjusted in-hospital LOS for patients transfused on the ward and during the entire hospitalization depending on whether they received ≤ 2 or ≥ 3 RBC transfusions. (for in-hospital transfusion: 10 [6; 24] days vs. 22 [13; 59] days ($p = 0.19$); for total hospitalization: 11 [6; 22] vs. 21 [10; 56] ($p = 0.17$)). Several hypotheses could explain this observation. First, patients presenting with hemorrhagic shock in the ED were excluded because they required immediate RBC transfusion. It is possible that some patients presented with acute bleeding during hospitalization, which would increase LOS and mortality despite not being present at ED admission [30]. Second, ED physicians may have initially preferred a restrictive transfusion strategy initially, followed by a liberal strategy on the ward [5]. Third, there may be a risk of iatrogenic anemia due to multiple blood tests on the ward, especially in patients admitted to the ICU [31]. Stricter control of the indications for blood tests, starting in the ED, may reduce the risk of iatrogenic anemia.

Limitations:

Our study has several limitations that must be acknowledged. This was a single-center study, and the local practice probably could not be extrapolated to all hospitals and areas. However, the present results are consistent with existing literature, with an in-hospital LOS for anemic patients with hemoglobin level ≤ 80 $g.dL^{-1}$, between 11 and 14 days [3]. In addition, all consecutive patients in a calendar year were included, which maximizes exhaustivity. The retrospective setting limited the collection of some data. However, the main parameters of interest were collected for all included patients and other data, as hemodynamic parameters were imputed by logistic regression. The choice of impute mortality by maximum in-hospital LOS should be discussed. This method lacks precision, compared to other methods such as Cox-model. However, it is easier to interpret and allows to consider two important outcomes in a single variable. Furthermore, considering short in-hospital LOS for dead

patients would have introduced an immortal time bias. The hemoglobin cut-off of 70 to 90 $g.L^{-1}$ may be a limitation. Recent recommendations suggest focusing more on anemia tolerance rather than hemoglobin level, and that a threshold of 70 $g.L^{-1}$ may be appropriate for most patients [6, 26]. We excluded patients with hemorrhagic shock or requiring an immediate hemorrhage control, who were likely to require immediate transfusion, regardless of their hemoglobin level. In the excluded population, 390 (69%) were not hospitalized. It would be interesting to compare these patients with those who were hospitalized. After propensity matching, only 118/564 (21%) patients remained. However, this reduction of the population is a known bias of a propensity-matched study. The score was developed taking into account significant differences in baseline cohort parameters and this adjustment allowed good comparability between groups. We could have chosen another primary outcome, such as ED LOS, which is quite higher in patients transfused in the ED. However, this issue is of concern to ED physicians and less so to hospitalists. The choice of death-adjusted in-hospital LOS allows to respond to hospitalists that transfusing stable anemic patients in the ED may not modify patient outcomes. Finally, we did not evaluate the appropriateness of RBC transfusion in the ED. This is the major limitation, as transfusion in the ED is often inappropriate [11, 12].

Conclusion

Among stable anemic patients with hemoglobin levels between 70 and 90 $g.L^{-1}$, requiring hospitalization, there was no difference in terms of adjusted in-hospital LOS when they were transfused in the ED. ED transfusion was associated with boarding and ED LOS. Future research should determine which patients should not be transfused in the ED, to improve the safety and efficiency of ED organizations.

List of abbreviations

ED	Emergency department
ICU	Intensive care unit
LOS	Length of stay
RBC	Red blood cells

Supplementary Information

The online version contains supplementary material available at https://doi.org/10.1186/s12873-025-01187-y.

Supplementary Material 1

Supplementary Material 2

Acknowledgements

Authors thank Sarah Kabani for editing the manuscript and Myriam Mezzarobba for her advice on statistical analysis.

Author contributions

Conceptualization: FC, CA, RG and LGM Data curation: CA; Formal analysis: FC; Investigation: CA; Methodology: FC, RG and LGM; Project administration: XB and RGG; Supervision: XB; Writing - original draft: FC, CA, TM; and Writing - review & editing: RG, LGM, XB, RGG.

Funding

None.

Data availability

Data is provided within the manuscript or supplementary information files.

Declarations

Ethics approval and consent to participate

The local ethics committee of Nimes' university hospital approved the study (Nîmes University Hospital IRB 23.05.02) and waived the consent in accordance with French law (Law no. 2012 – 300 of 5 March 2012 on research involving the human person). A non-opposition letter was sent to patients or their relatives if patients died during hospitalisation, explaining the aims of the study and the possibility of refusing data collection. The authors did not receive any refusals.

Consent for publication

Not applicable.

Competing interests

The authors declare no competing interests.

Clinical trial number

not applicable.

Received: 7 December 2024 / Accepted: 13 February 2025
Published online: 23 February 2025

References

1. McLean E, Cogswell M, Egli I, Wojdyla D, de Benoist B. Worldwide prevalence of anaemia, WHO Vitamin and Mineral Nutrition Information System, 1993–2005. Public Health Nutr. 2009;12:444–54.
2. Groenveld HF, Januzzi JL, Damman K, van Wijngaarden J, Hillege HL, van Veldhuisen DJ, et al. Anemia and mortality in heart failure patients: a systematic review and Meta-analysis. J Am Coll Cardiol. 2008;52:818–27.
3. Zaninetti C, Klersy C, Scavariello C, Bastia R, Balduini CL, Invernizzi R. Prevalence of anemia in hospitalized internal medicine patients: correlations with comorbidities and length of hospital stay. Euro J Intern Med. 2018;51:11–7.
4. Lanier JB, Park JJ, Callahan RC. Anemia in older adults. Am Fam Physician. 2018;98:437–42.
5. Carson JL, Stanworth SJ, Dennis JA, Trivella M, Roubinian N, Fergusson DA et al. Transfusion thresholds for guiding red blood cell transfusion. Cochrane Database Syst Rev. 2021; 2021:CD002042.
6. Carson JL, Stanworth SJ, Guyatt G, Valentine S, Dennis J, Bakhtary S, et al. Red blood cell transfusion: 2023 AABB International guidelines. JAMA. 2023;330:1892.
7. Spradbrow J, Lin Y, Shelton D, Callum J. Iron deficiency anemia in the emergency department: over-utilization of red blood cell transfusion and infrequent use of iron supplementation. CJEM. 2017;19:167–74.
8. Beverina I, Brando B. Prevalence of anemia and therapeutic behavior in the emergency department at a tertiary care hospital: are patient blood management principles applied? Transfus Apher Sci. 2019;58:688–92.
9. Quintana Díaz M, Borobia AM, García Erce JA, Maroun-Eid C, Fabra S, Carcas A, et al. Appropriate use of red blood cell transfusion in emergency departments:a study in five emergency departments. Blood Transfus. 2017;15:199–206.
10. Peyrony O, Gamelon D, Brune R, Chauvin A, Ghazali DA, Yordanov Y, et al. Red blood cell transfusion in the Emergency Department: an observational cross-sectional Multicenter Study. J Clin Med. 2021;10:2475.
11. Paganini M, Rigon F, Rebustello F, Cianci V, Bertozzi I, Randi ML. Appropriateness of packed red blood cells transfusions in chronic anemic patients in

the emergency department: the TRANSFUS-ED retrospective analysis. Intern Emerg Med. 2023;18:1815–21.
12. Langlais ML, Dargère M, Le Niger C, Goetghebeur D. [Appropriate use of red blood cell transfusion in the emergency department before and after a specific protocol]. Transfus Clin Biol. 2019;26:38–47.
13. Yao XI, Wang X, Speicher PJ, Hwang ES, Cheng P, Harpole DH, et al. Reporting and guidelines in propensity score analysis: a systematic review of Cancer and Cancer Surgical studies. J Natl Cancer Inst. 2017;109:djw323.
14. Janke AT, Melnick ER, Venkatesh AK. Hospital Occupancy and Emergency Department Boarding during the COVID-19 pandemic. JAMA Netw Open. 2022;5:e2233964.
15. Moretti K, Marqués CG, Garbern S, Mbanjumucyo G, Uwamahoro C, Beaudoin FL, et al. Transfusion, mortality and hemoglobin level: associations among emergency department patients in Kigali, Rwanda. Afr J Emerg Med. 2020;10:68–73.
16. Custer B, Zou S, Glynn S, Makani J, Tagny CT, Ekiaby ME, et al. Addressing gaps in International Blood availability and Transfusion Safety in Low and Middle Income Countries (LMIC): a NHLBI Workshop. Transfusion. 2018;58:1307–17.
17. Lee KS, Min HS, Moon JY, Lim D, Kim Y, Ko E, et al. Patient and hospital characteristics predict prolonged emergency department length of stay and in-hospital mortality: a nationwide analysis in Korea. BMC Emerg Med. 2022;22:183.
18. Bahrmann A, Benner L, Christ M, Bertsch T, Sieber CC, Katus H, et al. The Charlson Comorbidity and Barthel Index predict length of hospital stay, mortality, cardiovascular mortality and rehospitalization in unselected older patients admitted to the emergency department. Aging Clin Exp Res. 2019;31:1233–42.
19. Dharmarajan TS, Pankratov A, Morris E, Qurashi S, Law G, Phillips S, et al. Anemia: its impact on hospitalizations and length of hospital stay in nursing home and community older adults. J Am Med Dir Assoc. 2008;9:354–9.
20. Lotterman S, Sharma S. Blood Transfusion. In: StatPearls. Treasure Island (FL): StatPearls Publishing; 2024. Available on: http://www.ncbi.nlm.nih.gov/books/NBK499824/
21. Dunbar NM, Delaney M, Murphy MF, Pagano MB, Saifee NH, Seheult J, et al. Emergency departments are higher-risk locations for wrong blood in tube errors. Transfusion. 2021;61:2601–10.
22. Long B, Koyfman A. Red blood cell transfusion in the Emergency Department. J Emerg Med. 2016;51:120–30.
23. Roussel M, Teissandier D, Yordanov Y, Balen F, Noizet M, Tazarourte K, et al. Overnight stay in the Emergency Department and Mortality in older patients. JAMA Int Med. 2023;183:1378–85.
24. Carson JL, Brooks MM, Hébert PC, Goodman SG, Bertolet M, Glynn SA, et al. Restrictive or Liberal Transfusion Strategy in myocardial infarction and Anemia. N Engl J Med. 2023;389:2446–56.
25. Cobain TJ, Vamvakas EC, Wells A, Titlestad K. A survey of the demographics of blood use. Transfus Med. 2007;17:1–15.
26. Riveira MC, Fredrickson TA, Iha BR, Mitchell SH, White NJ, Arbabi S, et al. Improving emergency department blood product use through nursing education. Transfusion. 2020;60:1227–30.
27. Mueller MM, Van Remoortel H, Meybohm P, Aranko K, Aubron C, Burger R, et al. Patient blood management: recommendations from the 2018 Frankfurt Consensus Conference. JAMA. 2019;321:983–97.
28. Atsma F, Veldhuizen I, de Kort W, van Kraaij M, Pasker-de Jong P, Deinum J. Hemoglobin level is positively associated with blood pressure in a large cohort of healthy individuals. Hypertension. 2012;60:936–41.
29. Van Manen L, Deurvorst JM, Van Hezel ME, Boshuizen M, Van Bruggen R, Juffermans NP. Severity of illness influences the microcirculatory response to red blood cell transfusion in the critically ill: an observational cohort study. Crit Care. 2020;24:498.
30. Faria I, Thivalapill N, Makin J, Puyana JC, Raykar N, Bleeding. Hemorrhagic shock, and the global blood supply. Crit Care Clin. 2022;38:775–93.
31. Chant C, Wilson G, Friedrich JO. Anemia, transfusion, and phlebotomy practices in critically ill patients with prolonged ICU length of stay: a cohort study. Crit Care. 2006;10:R140.

Publisher's note