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Rates, Predictors of Blood Transfusion, And Changes of Hematocrit Level in Geriatric Hip Fractures

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Purpose: This study aimed to determine the prevalence and risk factors associated with blood transfusion in elderly patients with hip fractures, along with changes in hematocrit level during the first three days of hospitalization, to create more appropriate preoperative assessment guidelines.
Methods: Patients with intertrochanteric, femoral neck, and subtrochanteric fractures who underwent surgical treatment from May 1, 2021–April 30, 2023, were included. Multivariate analysis was used to identify predictors of blood transfusion. Changes in hematocrit level during the first three days of hospitalization were also calculated.
Results: Blood transfusion rate among elderly patients with hip fractures who underwent surgery was 43.12%. Multivariable analysis identified three significant risk factors for transfusion: age over 75 years (odds ratio [OR] 2.61 [1.38-4.91], p=0.003), intertrochanteric fractures (OR 2.97 [1.10-7.96], p=0.031), and initial hematocrit <30.0% (OR 55.61 [16.26-190.15], p<0.001). Patients with an initial hematocrit level ≥36.0% had a transfusion rate of 16.10%, while those with a level above 43.2% did not require transfusion. The mean hematocrit level decrease was 1.73±0.46% in extracapsular fractures and 0.74±2.65% in intracapsular fractures.
Conclusions: Elderly patients with hip fracture with an initial hematocrit level of <36% should be considered for serial preoperative blood testing and intraoperative blood reservation. For those with a hematocrit level 36.0–43% may not require preoperative blood testing and reservation, based on the physician's discretion, and levels >43% generally do not necessitate preoperative blood testing or reservation.

Keywords: Hip fracture, Elderly, Blood transfusion, Hematocrit level, Hip fracture surgery

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Hip fractures cause significant pain and limit the patient's functional ability. The recommended treatment for elderly patients with hip fractures is internal fixation with implants or hip replacement surgery to restore hip function. Surgery performed within 48–72 hours of hospital admission can significantly reduce the risk of complications associated with prolonged bed rest, such as aspiration pneumonia, urinary tract infections, and pressure ulcers[1,2].

During the course of treatment, some patients develop anemia, either preoperatively, due to pre-existing anemia, underlying medical conditions, or bleeding at the fracture site caused by trauma, or intraoperatively as a result of blood loss from the surgical procedure. As a standard protocol, blood is drawn and cross-matched for all patients before surgery, and blood transfusion is administered when anemia is detected to ensure that patients are optimized for surgery. Due to the limited blood supply at the hospital's blood bank, the lack of available blood prior to surgery results in delayed operative management. Moreover, there are currently no data on the transfusion rate in elderly patients with hip fractures.

A review of the literature indicates that patients with hip fractures experience a decline in hemoglobin levels during the preoperative period (hidden blood loss), which may continue to decrease up to 48 hours after the injury. This decline is greater in extracapsular hip fractures than in intracapsular fractures[3,4]. At our hospital, there is a protocol for assessing hematocrit levels by performing daily capillary blood tests during the first three days of hospitalization in all elderly patients with hip fracture to screen for anemia. However, frequent blood draws may cause discomfort to patients and increase the workload of nurses and laboratory staff. Therefore, the objective of this study was to determine the rate and risk factors for blood transfusion in elderly patients with hip fractures, assess changes in hematocrit levels during the first three days of admission, and quantify the extent of hematocrit level decrease. The goal of this study was to develop a more appropriate protocol for preoperative planning and reduce unnecessary blood tests.

Objectives

1. The primary objective of this study was to determine the rates and risk factors associated with blood transfusion in elderly patients with hip fractures.

2. The secondary objective was to assess the natural change in hematocrit levels during the first three days of hospitalization, excluding patients who underwent surgery or received transfusions within this period.

METHODS

Study Design

This retrospective cohort study used data collected from the hospital's electronic medical records (EMR).

Population and Sample

The study population included patients aged 55 years and older who were diagnosed with intertrochanteric, femoral neck, basicervical, or subtrochanteric hip fractures and underwent surgical treatment between May 1, 2021, and April 30, 2023.

Inclusion Criteria

Patients aged 55 years or older who were diagnosed with hip fractures and underwent surgical treatment.

Exclusion Criteria

1. Patients with injury of more than two weeks prior to admission.

2. Patients with a history of hip fractures or prior surgery of the ipsilateral hip.

3. Patients with additional fractures other than the hip.

4. Patients diagnosed with preexisting inherited anemic disorder (thalassemia or hemoglobinopathies).

5. Patients with a history of bleeding from other parts of the body, such as intra-abdominal hemorrhage or open wounds, experience significant blood loss.

Additional Exclusion Criteria for Secondary Outcome Analysis

1. Patients who underwent surgery in the 72-hour period after admission.

2. Patients who received blood transfusions in the 72-hour period after admission.

Data Collection Procedure

1. The records of elderly patients with hip fractures who underwent surgical treatment were retrieved from the hospital's inpatient index database.

2. Patients were selected based on the predefined inclusion and exclusion criteria.

3. Data were extracted from the inpatient medical records, including age, sex, weight, height, comorbidities, history of alcohol use, smoking status, cause of injury, time from injury to hospital admission (in days), diagnosis, fracture type, hematocrit levels before and after surgery, time to surgery (in days), operative time (in minutes), American Society of Anesthesiologists (ASA) classification, surgical procedure, estimated blood loss (in milliliters), transfusion data, volume of blood transfused, and whether the patient received a transfusion preoperatively, intraoperatively, or postoperatively.

4. Primary outcome analysis: The study population was divided into two groups: those who received blood transfusions and those who did not. Statistical methods were used to calculate the rate and risk factors for blood transfusion in elderly patients with hip fractures.

5. Secondary outcome analysis: To determine the rate of change in hematocrit levels during the first three days of hospitalization, excluding patients who underwent surgery or received transfusions within this period.

Surgical Procedures

The surgical interventions were categorized according to the type of implant used. Internal fixation procedures included cephalomedullary nail fixation (proximal femoral nail antirotation; PFNA), dynamic hip screw with plate fixation (DHS), multiple screw fixation, and locking compression plate fixation (LCP). Arthroplasty procedures are classified as bipolar hemiarthroplasty (HA), total hip arthroplasty (THA), or other types of hemiarthroplasty (e.g., Austin Moore). The other procedures included external fixation and skeletal traction.

Data Analysis and Statistical Methods

1. Descriptive statistics were used to summarize the baseline characteristics of the study population, transfusion rates, and changes in hematocrit levels. These included frequencies, percentages, means, and standard deviations.

2. Fisher's exact test was employed to compare categorical variables between groups.

3. Independent sample t-tests were used to compare continuous variables between the transfused and non-transfused groups.

4. Paired sample t-tests were used to assess changes in hematocrit levels over time in the same individuals.

5. Univariate and multivariate logistic regression analyses were performed to identify risk factors associated with blood transfusion in elderly patients with surgically treated hip fractures.

Ethical Considerations

The Human Research Ethics Committee of our hospital approved this study (Protocol No. EC CRH 018/67; Document No. CR 0033.102/Research/EC67-178).

RESULTS

A total of 477 patients aged > 55 years who were diagnosed with hip fractures and underwent surgical treatment between May 1, 2021, and April 30, 2023, were initially reviewed. After applying the exclusion criteria, 385 patients were eligible for analysis. A total of 166 patients (43.12%) received blood transfusion during hospitalization (Table 1). A total of 118 patients (71.08%) received preoperative transfusions, 22 (13.25%) received intraoperative transfusions, and 88 (53.01%) received postoperative transfusions.

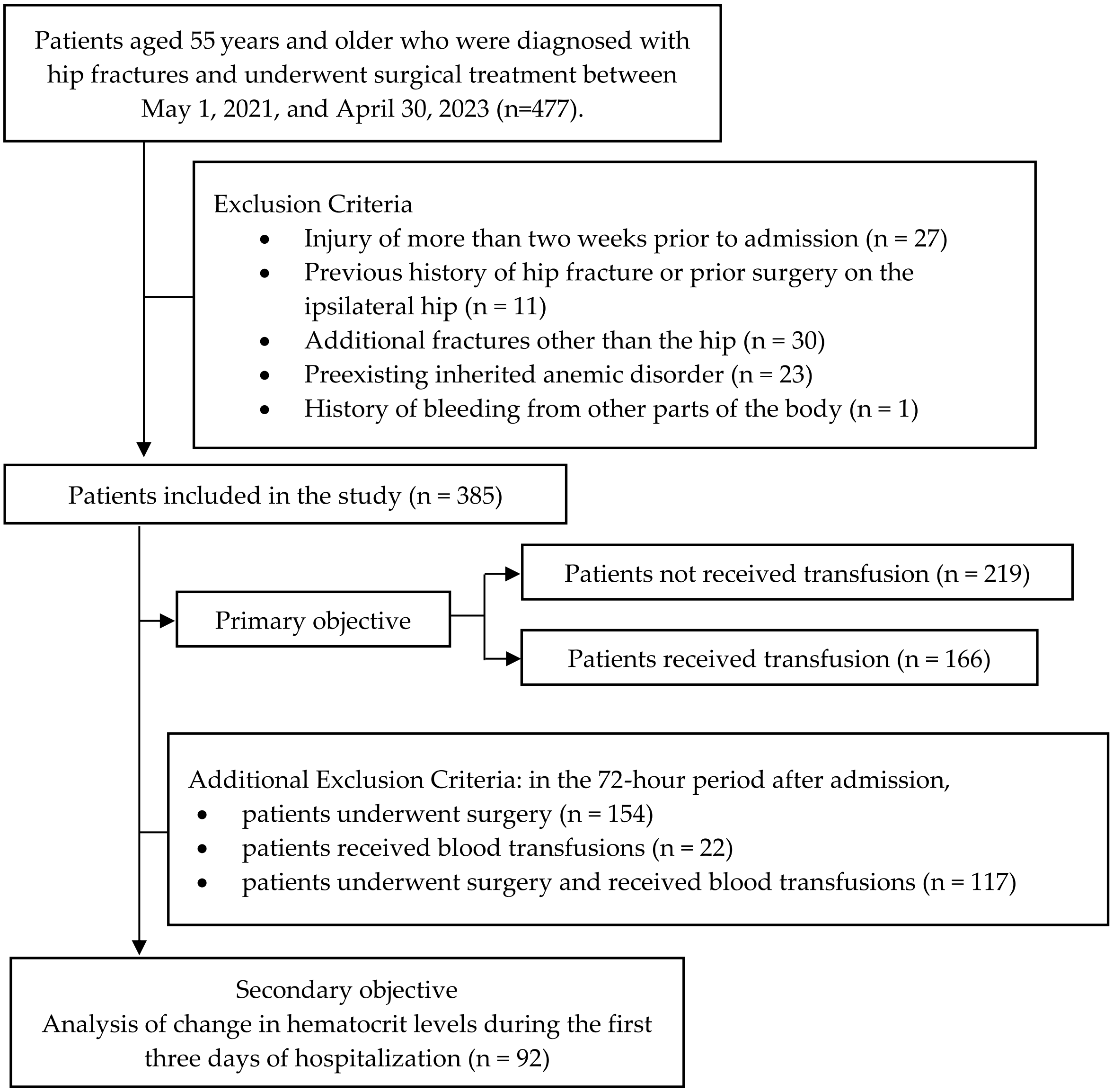

Fig. 1 Study Flow Chart.

Most intertrochanteric fractures were treated with PFNA (n = 230), followed by DHS (n = 12), HA (n = 5), LCP (n = 5), and Austin–Moore hemiarthroplasty (n = 1). The most common procedure used for femoral neck fractures was HA (n = 100), followed by PFNA (n = 4), multiple screw fixation (n = 3), DHS (n = 2), THA (n = 1), and Austin–Moore hemiarthroplasty (n = 1). For basicervical neck fractures, HA was performed in 2 patients and DHS in 1 patient. The preferred procedures for the treatment of subtrochanteric fractures were Long PFNA (n = 13), LCP (n = 4), and other procedures (n=2).

Primary Outcome

Hematocrit level on admission is a major predictor of blood transfusion. Patients with an admission hematocrit level < 30% had a 96.05% chance of receiving a transfusion. Patients with a hematocrit level > 36% on admission had a transfusion rate of 17.43% (Table 1). Patients with hematocrit levels >43.2% on admission did not require transfusion.

Univariate regression analysis revealed that several factors were significantly associated with blood transfusions. These included age > 75 years ($p < 0.001$), body mass index (BMI) less than 20 kg/m² ($p = 0.001$), intertrochanteric fracture type ($p < 0.001$), high-energy trauma pattern ($p = 0.047$), cephalomedullary nail surgery ($p < 0.001$), surgical delay > 72 hours ($p < 0.001$), and hematocrit level < 30% ($p < 0.001$) (Table 2).

Multivariable regression analysis identified that age over 75 years (OR 2.61 [1.38 - 4.91], $p = 0.003$), intertrochanteric fracture type (OR 2.97 [1.10 - 7.96], $p = 0.031$), and admission hematocrit level <30% (OR 55.61 [16.26 - 190.15], $p < 0.001$) were significant risk factors for blood transfusion (Table 2).

Table 1 Patient characteristics.

Baseline characteristics	Total (n=385)		p-value**
	Not received transfusion n=219 (56.88%)	Received transfusion n=166, (43.12%)	
Age*	73.85 (±8.76)	78.54 (±8.53)	<0.001
Sex			0.073
Male	75 (64.10%)	42 (35.90%)	
Female	144 (53.73%)	124 (46.27%)	
Body mass index (BMI)*	21.72 (±3.81)	20.44 (±3.84)	0.00
ASA classification			0.200
2	30 (66.67%)	15 (33.33%)	
3	189 (55.59%)	151 (44.41%)	
Type of hip fracture			
Intertrochanteric	128 (50.59%)	125 (49.41%)	0.001
Femoral neck	81 (73.64%)	29 (26.36%)	<0.001
Basicervical neck	3 (100%)	0 (0%)	0.262
Subtrochanteric	7 (36.84%)	12 (63.16%)	0.095
Co-morbidity			
Hypertension	128 (54.24%)	108 (45.76%)	0.206
Dyslipidemia	78 (61.90%)	58 (42.65%)	0.915
Diabetes	35 (57.47%)	33 (48.53%)	0.346
CKD	20 (43.48%)	26 (56.52%)	0.057
Gout	20 (62.50%)	12 (37.50%)	0.578
COPD	18 (60.00%)	12 (40.00%)	0.848
Coronary artery disease	4 (66.67%)	2 (33.33%)	0.703
Cerebrovascular disease	3 (60.00%)	2 (40.00%)	1.000
Others	70 (56.45%)	54 (43.55%)	0.913
Antiplatelet use	21 (58.33%)	15 (41.67 %)	1.000
Anticoagulant use	5 (50.0%)	5 (50.0%)	0.751
Alcohol consumption	32 (66.67%)	16 (33.33%)	0.163
Smoking	26 (63.41%)	15 (36.59%)	0.408
Trauma pattern			0.131
Low energy trauma	198 (55.62%)	158 (44.38%)	

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Baseline characteristics	Total (n=385)		p-value**
	Not received transfusion n=219 (56.88%)	Received transfusion n=166, (43.12%)	
High energy trauma	17 (77.27%)	5 (22.73%)	
Operation			
Cephalomedullary nail	124 (50.41%)	122 (49.59%)	0.001
Bipolar hemiarthroplasty	77 (71.96%)	30 (28.04%)	<0.001
Other operation	18 (56.25%)	14 (43.75%)	1.000
Duration before admission			0.392
≤24 hours	182 (55.83%)	144 (44.17%)	
>24 hours	37 (62.71%)	22 (37.29%)	
Duration before surgery			0.001
≤72 hours	194 (61.01%)	124 (38.99%)	
>72 hours	25 (37.31%)	42 (62.69%)	
Operative time (continuous)*	43.49 (±22.83)	44.97 (±21.07)	0.515
Estimated blood loss by surgeon			0.52
<100 ml	69 (54.33%)	58 (45.67%)	
100-199 ml	76 (59.84%)	51 (40.16%)	
200-299 ml	29 (52.73%)	26 (47.27%)	
>300 ml	15 (46.88%)	17 (53.13%)	
Estimated blood loss by anesthesiologist			0.536
<100 ml	75 (55.56%)	60 (44.44%)	
100-199 ml	91 (61.90%)	56 (38.10%)	
200-299 ml	35 (54.69%)	29 (45.31%)	
≥300 ml	18 (48.65%)	19 (51.35%)	
Hematocrit level on admission (%)			<0.001
<27	0 (0%)	32 (100%)	
27.0-29.9	3 (6.82%)	41 (93.18%)	
30.0-32.9	35 (50.72%)	34 (49.28%)	
33.0-35.9	57 (65.52%)	30 (34.48%)	
≥36	99 (83.90%)	19 (16.10%)	
Type of fracture and surgery			
Intertrochanteric fracture			1.000
Cephalomedullary nail	116 (50.43)	114 (49.57%)	
Other operation	12 (52.17%)	11 (47.83%)	
Femoral neck fracture			0.286
Bipolar hemiarthroplasty	72 (72.0%)	28 (28.0%)	
Other operation	9 (90.0%	1 (10.0%)	

* Age, BMI, Operative time, and estimated blood loss are presented as mean (SD), while other categorical variables are presented as N (%).

** To calculate p value, Fisher's exact test is used for categorical data and independent sample t-test is used for numerical data

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Table 2 Univariate and multivariate regression analysis.

Covariate	Univariate regression analysis		Multivariate regression analysis	
	Crude odds ratio (95% confidence interval)	p-value	Adjusted odds ratio (95% confidence interval)	p-value
Age > 75 years	1.61 (1.32 – 1.96)	<0.001	2.60 (1.38 – 4.89)	0.003
Female	1.14 (1.00 – 1.29)	0.059	1.56 (0.87 – 2.08)	0.134
BMI <20 kg/cm²	1.52 (1.18 – 1.96	0.002	1.44 (0.69 – 2.03)	0.331
ASA classification 3	1.05 (0.98 – 1.13)	0.159	0.51 (0.21 – 1.27)	0.147
Intertrochanteric fracture	1.29 (1.12 – 1.48)	<0.001	3.05 (1.13 – 8.23)	0.027
Alcohol consumption	0.66 (0.37 – 1.16)	0.144	0.94 (0.30 – 2.95)	0.921
Smoking	0.76 (0.42 – 1.39)	0.372	1.00 (0.30 – 3.32)	0.996
Chronic kidney disease	1.72 (0.99 – 2.96)	0.050	0.99 (0.36 – 2.67)	0.966
Antiplatelet use	0.94 (0.47 – 1.88)	1.000	0.53 (0.06 – 4.50)	0.563
Anticoagulant use	1.33 (0.38 – 4.67)	0.751	1.36 (0.48 – 3.88)	0.568
High energy trauma pattern	0.39 (0.15 – 1.03)	0.047	0.80 (0.23 – 2.79)	0.725
Cephalomedullary nail surgery	1.30 (1.12 – 1.50)	<0.001	1.07 (0.40 – 2.83)	0.892
Duration before surgery >72 hours	2.22 (1.41 – 3.48)	<0.001	1.94 (0.87 – 4.28)	0.101
Operative time >60 minutes	1.07 (0.69 – 1.66)	0.763	1.57 (0.72 – 3.46)	0.259
Estimate blood loss by surgeon >200 ml	1.02 (0.77 – 1.35)	0.911	1.32 (0.70 – 2.46)	0.390
Hematocrit on admission date <30 mg%	31.92 (10.27 – 99.21)	<0.001	56.01 (16.34 – 191.97)	<0.001

The hematocrit level on admission was associated with preoperative blood transfusion. Patients with admission hematocrit levels of 30.0%–32.9% and 33.0%–35.9% experienced hematocrit level declines, leading to preoperative transfusion rates of 31.88% and 18.18%, respectively. Patients with hematocrit levels on admission ≥36% had a 5.98% chance of receiving preoperative blood transfusion (Table 3).

Table 3 Hematocrit level on admission and preoperative blood transfusion*.

Hematocrit on admission (%)	Total (n=350)	
	Not received pre-op transfusion	Received pre-op transfusion
< 27.0	0 (0%)	32 (100%)
27.0 - 29.9	9 (20.45%)	35 (79.55%)
30.0 - 32.9	47 (68.12%)	22 (31.88%)
33.0 - 35.9	72 (81.82%)	16 (18.18%)
≥ 36.0	110 (94.02%)	7 (5.98%)

*p-value < 0.001

Secondary Outcome

When comparing the decrease in hematocrit levels during the first 3 days of admission, the researchers had to exclude patients who either underwent surgery or received blood transfusions within 72 hours, as these factors cause changes in hematocrit levels. After excluding surgical and transfusion patients, 92 patients were included in the analysis. Among this group, patients with extracapsular and intracapsular hip fractures showed average hematocrit decreases of 1.73 ± 0.46% and 0.74 ± 2.65%, respectively (Chart 1).

After surgery, patients with intertrochanteric fractures, femoral neck fractures, and subtrochanteric fractures experienced hematocrit decreases of 2.81 ± 3.62%, 3.63 ± 3.28%, and 1.78 ± 2.21%, respectively. When considering surgical methods, patients undergoing cephalomedullary nail surgery showed a postoperative hematocrit decrease of 2.81 ± 3.59%, while those who underwent bipolar hemiarthroplasty had a decrease of 3.70 ± 3.33%.

One patient experienced side effects related to the blood transfusion, including chills, dizziness, fainting, and skin flushing. No severe transfusion reactions were observed.

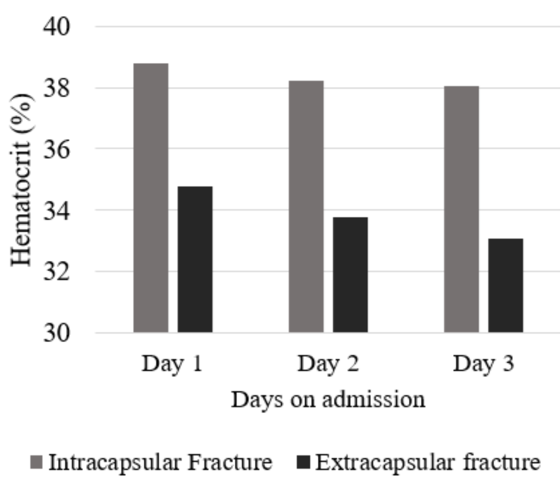

Chart 1 Hematocrit decline within the first 3 days of hospitalization in patients with intracapsular and extracapsular hip fractures.

DISCUSSION

Elderly patients with hip fracture who underwent surgery at our hospital had a blood transfusion rate of 43.12%. Significant risk factors for receiving a transfusion included age > 75 years, intertrochanteric fracture type, and initial hematocrit level < 30%. The reported transfusion rates in other studies vary widely, ranging from 23.14% to 74.42% [5-8]. These variations can be attributed to differences in the study population sizes and baseline characteristics of the patients in each study.

Advanced age was a significant risk factor for blood transfusion, which is consistent with previous research showing that patients with hip fractures aged > 65 years have a significantly higher transfusion rate than those under 65[9]. Additionally, other studies have identified increasing age as a predictor of transfusion[10], likely due to an age-related decline in bone marrow function as well as a lower transfusion threshold in older patients[9]. Older adults also tend to have lower hematocrit levels upon hospital admission, potentially due to malnutrition, the use of several medications, reduced bone marrow function, and greater blood loss following injury[11].

Intertrochanteric fractures have been identified as risk factors for blood transfusion in elderly patients undergoing surgery for hip fractures. This finding aligns with that of previous studies reporting that patients with intertrochanteric fractures are more likely to receive blood transfusions than those with femoral neck fractures[3,5,12]. Although intertrochanteric fractures are often treated with cephalomedullary nailing, a surgical technique associated with a smaller reduction in hematocrit levels than the bipolar hemiarthroplasty used for femoral neck fractures, patients with intertrochanteric fractures still tend to receive more transfusions. This may be attributed to lower baseline hematocrit levels on admission and greater preoperative blood loss. In femoral neck fractures, especially when the joint capsule remains intact, bleeding is often confined within the hip joint, where the limited space reduces overall blood loss. In contrast, extracapsular fractures such as intertrochanteric fractures allow for more extensive bleeding into the surrounding soft tissues, increasing blood loss[3,13].

A hematocrit level < 30% is significantly associated with an increased risk of blood transfusion. At our hospital, the Department of Anesthesiology recommends that elderly patients undergoing hip fracture surgery have a minimum hematocrit level of 27% before surgery. However, recent studies have suggested that the threshold for transfusion can be safely reduced to as low as 22.7–23.0% without increasing mortality or complictions related to anemia while potentially decreasing the adverse effects associated with blood transfusions[14]. These adverse effects may include acute hemolytic transfusion reactions due to mismatched blood products, transfusion-transmitted infections, respiratory complications, and allergic reactions[15]. A limited transfusion strategy can also lead to shorter hospital stay, lower healthcare costs, reduced mortality rates, and decreased hospital readmission rates[14].

Previous studies have compared two different transfusion strategies: the restrictive strategy, in which blood transfusion is administered only when patients exhibit symptoms of anemia or at the physician's discretion when hemoglobin levels fall below 8.0 g/dL (approximately equivalent to a hematocrit level of 24%), and the liberal strategy, in which transfusion is given when hemoglobin falls below 10.0 g/dL (equivalent to a hematocrit level of 30%). Research suggests that this restrictive approach is generally safe and does not increase complications related to anemia[15]. However, in elderly patients with hip fractures, there may be increased risks associated with anemia owing to advanced age, underlying comorbidities, and the physiological effects of low hemoglobin levels, which can result in fatigue, weakness, and reduced exercise tolerance. These symptoms may delay postoperative mobilization and rehabilitation. Therefore, there is no universally established transfusion threshold for this patient population[16].

Hematocrit level monitoring during the first 3 days of hospitalization can help screen for anemia in elderly patients with hip fractures. The study found that patients with initial hematocrit levels between 30.0%–32.9% and 33.0%–35.9% required preoperative blood transfusion in 31.88% and 18.18% of cases, respectively. Patients with hematocrit levels ≥36.0% had an overall transfusion rate of 17.43% during hospitalization; however, only 5.47% required a transfusion before surgery. Notably, patients with hematocrit levels >43.2% did not receive perioperative blood transfusions.

Based on these findings, the following recommendations are proposed:

- Patients with a hematocrit level <36.0% on admission should undergo repeat hematocrit testing during hospitalization and have blood reserved in advance for surgery.
- Patients with a hematocrit level of 36.0%–43% on admission may be considered for repeat hematocrit testing and preoperative blood reservation based on clinical judgment, considering additional risk factors such as age and fracture type.
- Patients with an initial hematocrit level >43% generally do not require further hematocrit testing or blood reservation before surgery.

Prolonged time to surgery was associated with an increased blood transfusion rate, although this was not statistically significant. This is consistent with a previous study that found that patients who underwent surgery within 24 hours had a lower transfusion rate than those who underwent surgery after 24 hours[17]. Researchers have suggested that a higher rate of preoperative anemia in these patients often necessitates blood transfusion prior to surgery. The processes involved in blood reservation, transfusion, and repeated blood testing may have contributed to surgical delays in this patient group.

Longer operative time and greater intraoperative blood loss tended to be risk factors for blood transfusion; however, the difference was not statistically significant. The average operative time for patients who received transfusions was 44.97 minutes, compared to 43.49 minutes for those who did not receive transfusions. This finding contrasts with those of other studies that reported that the operative time significantly influenced the likelihood of postoperative transfusion[6]. Furthermore, another study found that operative time was a significant risk factor for transfusion in patients with pertrochanteric hip fractures, with an average operative times of 82.6 minutes in the transfused group and 72.7 minutes in the non-transfused group[18], suggesting that a shorter average operative time at our hospital compared to other studies may reduce the amount of blood loss, thus minimizing the impact of operative time as a risk factor for transfusion in this cohort.

Injury caused by high-energy trauma patterns was not associated with the need for blood transfusion in patients with hip fractures. This finding is inconsistent with a previous study showing that patients with hip fractures resulting from high-energy trauma have a higher likelihood of receiving blood transfusions than those injured by low-energy trauma[19]. Patients with high-energy trauma often sustain multiple injuries owing to the severity of the accident, which increases the chance of having more than one fracture site. Patients were excluded from the study based on the following exclusion criteria. This resulted in a smaller proportion of high-energy trauma cases being included in the study, which may not have fully represented the entire population of patients with high-energy trauma. Therefore, the analysis of this risk factor may not accurately reflect the true association.

After hip surgery, hematocrit levels were found to decrease by 3.11%±3.75%. There is a recommendation for a restrictive transfusion strategy, in which blood is administered only when patients show symptoms of anemia or when hematocrit levels fall below 24%[15]. A preoperative hematocrit threshold of greater than 27% used by the anesthesiology department at the hospital seems appropriate; however, each patient should be evaluated individually. Physicians deciding on transfusion should carefully weigh the risk of anemia against transfusion complications. Patients at high risk of oxygen deprivation, such as those with heart disease, stroke, or acute renal failure, may require transfusion at higher hematocrit thresholds[16].

Regarding the strategies for reducing blood transfusion rates, tranexamic acid administration has been shown to effectively reduce perioperative blood loss and the need for transfusion in elderly patients with hip fractures. Evidence indicates that tranexamic acid is generally safe in this population, with no significant increase in thromboembolic events[20,21].

Iron supplementation or erythropoietin administration is not recommended, as studies in Thai elderly populations have found that iron deficiency accounts for only 3.05–3.6% of anemia cases, whereas thalassemia-related anemia accounts for as much as 25.95–56.2%[22,23]. Iron supplementation in patients with thalassemia may cause iron overload, and erythropoietin stimulation may be ineffective in those whose bone marrow cannot adequately produce red blood cells due to thalassemia.

Study Limitations

This study used retrospective data collected from electronic medical records, which resulted in incomplete data. Moreover, certain risk factors such as ASA classification and chronic kidney disease had insufficient sample sizes, which may have led to potential inaccuracies in the risk factor analysis.

Estimated blood loss was recorded by the operating surgeon and anesthesiologist, which is subjective and may vary between operators and can be underestimated[24]. Future studies should use more standardized measurement methods to provide a more objective estimation of blood loss.

For the secondary objective analysis, reporting the decrease in blood concentration levels, large number of patients who received blood transfusions or underwent surgery within the first three days of hospitalization were excluded from the analysis and the calculated results may underestimate the hidden blood loss which requires transfusion.

This study used hematocrit values instead of hemoglobin values, as serial blood measurements were available from capillary blood test records as a percentage of hematocrit. While hemoglobin is more commonly reported in transfusion guidelines, hematocrit and hemoglobin are strongly correlated, and hematocrit is also routinely used in clinical practice. Nevertheless, plasma volume changes may influence hematocrit more than hemoglobin, which should be considered when interpreting our results. Our proposed hematocrit cutoff points (<36% and >43%) were based on single-center retrospective data and may not be generalizable. External validation in larger prospective multicenter studies is recommended.

CONCLUSION

The findings of this study can be applied clinically as a guideline for blood testing and reservation prior to surgery. Specifically, patients with an initial hematocrit level of less than 36% should be considered for repeat hematocrit testing and preoperative blood reservation. For patients with an initial hematocrit level between 36.0% and 43%, blood testing and reservation before surgery may be decided at the physician's discretion, considering other risk factors. Patients with an initial hematocrit level > 43% do not require preoperative blood testing or reservations.

For future research, prospective studies with larger sample sizes are recommended to enhance the reliability of the results and ensure sufficient sample sizes for the analysis of certain risk factors.

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