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ORIGINAL RESEARCH

Preoperative Anemia and Perioperative Outcomes in Gynecological Surgery: A Single-Center Retrospective Study

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Purpose: To investigate the incidence and clinical characteristic of preoperative anemia and its impacts on perioperative outcomes in gynecological inpatients.

Patients and Methods: We retrospectively collected data from surgical patients admitted to the Department of Gynecology at Peking University People's Hospital between April 2023 and January 2024. The data included demographic information, preoperative laboratory tests, diagnoses, surgery records, and hospitalization information. Preoperative anemia was defined as hemoglobin (Hb) concentration less than 120 g/L according to the last blood test before surgery. The primary outcomes of this study were perioperative complications, including infection, heart failure, thromboembolic events, intestinal obstruction, and transfer to the intensive care unit (ICU). Secondary outcomes included perioperative RBC transfusion, length of stay (LOS) and hospitalization costs. Outcomes were compared between the anemic group and non-anemic group, and logistic regression analyses were used to identify risk factors associated with the study outcomes.

Results: This study included a total of 2,519 patients, and the incidence of preoperative anemia was 30.8%. Compared with the non-anemic group, those in anemic group had younger age (44 vs 47, $P < 0.001$) and lower body mass index (BMI) (23.2 vs 23.9, $P < 0.001$); however, higher incidences of perioperative RBC transfusion (10.7% vs 1.7%, $P < 0.001$) and complications (4.4% vs 0.9%, $P < 0.001$), higher hospitalization costs (14531 vs 13681, $P = 0.044$) and longer LOS (6 vs 5, $P < 0.001$). According to multivariate analyses, lower BMI (aOR = 0.893, $P = 0.016$), having comorbidity (aOR = 4.422, $P < 0.001$), preoperative anemia (aOR = 6.259, $P < 0.001$), gynecological malignancy (aOR = 4.376, $P < 0.001$), longer surgery duration (aOR = 1.010, $P < 0.001$) and increased blood loss (aOR = 1.002, $P < 0.001$) were associated with higher incidences of perioperative complications. Based on final surgical pathology, we divided surgical patients into gynecologic malignancy and non-malignancy groups. Similar results were obtained in both groups, preoperative anemia remained a facilitating factor of perioperative RBC transfusion and complication. Additionally, we investigated whether patient blood management (PBM) before surgery could improve perioperative outcomes. The results revealed that preoperative RBC transfusion was a protective factor against perioperative complication (aOR = 0.032, $P = 0.017$), while the relationship between iron supplementation and perioperative complication remained unclear (aOR = 0.628, $P = 0.502$).

Conclusion: Preoperative anemia was related to higher incidence of perioperative RBC transfusion and complication, and it increased hospitalization costs and prolonged LOS in gynecological inpatients. PBM before surgery could help improve perioperative outcomes. These findings emphasized the importance of early identification and active management of anemia, which might help reduce transfusion needs, minimize complications, and ultimately enhance gynecological inpatients' outcomes.

Keywords: anemia, patient blood management, perioperative complications, perioperative transfusion

Introduction

The incidence of preoperative anemia in gynecological inpatients ranges from 24–45%,[1,2] diseases like endometrial polyps, gynecological malignancy, uterine leiomyoma and adenomyosis are the common causes. The diagnostic threshold for anemia is

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related to age, gender and ethnicity. A statistical analysis incorporating 18 individual datasets from 8 countries (China involved) revealed that, in non-pregnant females aged 18–65 years, the fifth centile was 119.7 g/L.[3] This was essentially consistent with the World Health Organization (WHO) criteria.[4] Therefore, using 120g/L as the diagnostic threshold for anemia was reasonable. Even mild, preoperative anemia is associated with increased risk of perioperative transfusion and increased morbidity (such as infection, thromboembolic events and intestinal obstruction) and mortality after surgery.[5–10] It can also affect patients' recovery, prolong length of stay (LOS) and increase hospitalization costs.[2,5,8] In view of these adverse effects, the International Consensus Conference on Patient Blood Management (PBM) in Frankfurt in 2018 strongly recommended timely identification and appropriate management of anemia before major elective surgery.[11] The most common interventions included restrictive red blood cell (RBC) transfusion, using pharmacologic hemostatic agents and iron therapy.

To promote and implement PBM, Chinese clinicians also published the Expert Consensus on Perioperative Blood Management in Gynecological Patients in 2019.[12] However, a national cross-sectional study to assess the prevalence and intervention of preoperative anemia conducted in 2021 showed that, the overall prevalence of preoperative anemia in China was 27.57%, but the intervention rate was only 12.57%.[13] It indicated that preoperative anemia was a relatively common issue in China that had not been fully appreciated. This might lead to unnecessary blood transfusion and increase the risk of perioperative complication. Furthermore, previous literatures on preoperative anemia in gynecology has mostly focused on elective major surgery or malignant tumor surgery. Comprehensive data on preoperative anemia in gynecological surgeries remained scarce, particularly within the Chinese population.

Therefore, our center conducted a single-center, retrospective study to investigate the incidence of preoperative anemia and its impact on perioperative outcomes, including perioperative complication, perioperative RBC transfusion, hospitalization costs and LOS.

Materials and Methods

Subjects

This was a single-center, retrospective study using data collected from surgical patients admitted to the Department of Gynecology at Peking University People's Hospital between April 2023 and January 2024. The data included demographic information, preoperative laboratory tests, diagnoses, surgery records, and hospitalization information. Patients under 18 years old or with missing pre-operative hemoglobin lab recordings within 30 days prior to operation or other significant information were excluded. All preoperative diagnoses in this study were based on International Classification of Diseases (ICD) −10 codes and the diagnosis of malignant tumors was based on the final surgical pathology.

The sample size required for this study was calculated using Power Analysis and Sample Size (PASS) 2021 software, based on the different perioperative complication rates between the anemic group and the non-anemic group. Previous literature indicated that the prevalence of preoperative anemia among Chinese adult women was 31.5%.[13] Based on preliminary statistics from our center, the perioperative complication rate in anemic patients is approximately 4% (p1), while that in non-anemic patients is about 0.5% (p2). Therefore, we employed the formula for comparing two independent proportions, setting the test power at 90% and the two-sided significance level at 0.05. The sample size for the anemic group was designated as N1, and that for the non-anemic group as N2, with N2/N1 = 2.3. Calculations indicated the minimum sample sizes for the two groups were 348 and 800, respectively.

Variables

This study used the WHO criteria to screen and estimate the degree of anemia. It defined anemia as a hemoglobin concentration less than 120 g/L in non-pregnant adult females (mild: 110–119 g/L, moderate: 80–109 g/L, severe: <80 g/L).[3,4] Demographic data included age, body mass index (BMI) and comorbidities. Diagnoses were based on ICD-10. Surgery records encompassed surgery grade, surgery duration and volume of blood loss; the surgery grade was based on the Management Measures for Surgery Grading in Medical Institutions issued by China's National Health Commission, which categorized surgeries into Grade 1 to 4 according to factors such as surgery risk, complexity, and consumed resources. A greater number indicated higher surgery risk and increased complexity. Hospitalization information covered LOS and hospitalization costs.

The primary outcomes of this study were perioperative complications, including infection, heart failure, thromboembolic event, intestinal obstruction, and transfer to the intensive care unit (ICU). Infection encompassed surgical site infection, respiratory tract infection, gastrointestinal infection, urinary tract infection and sepsis, which were diagnosed based on definitive pathogenetic evidence or consultation with infectious disease specialists. Thromboembolic events encompassed deep vein thrombosis, pulmonary embolism, acute myocardial infarction and stroke, diagnosed based on definitive imaging evidence. Secondary outcomes included perioperative red blood cell (RBC) transfusion, LOS and hospitalization costs. Our center used restrictive transfusion strategy, in which a trigger of Hb concentration <70 g/L was recommended. Outcomes were collected from 7 days before surgery to 30 days after surgery.

Statistical Analysis

Descriptive statistical analysis was used. Continuous variables were presented as medians (interquartile range (IQR)), and categorical variables were presented as frequencies (percentages). The distribution of continuous variables was compared using the Mann–Whitney *U*-test or the Kruskal–Wallis *H*-test, categorical variables were compared using the χ^2 test. Univariate logistic regression analysis was used to screen for confounding variables. Variables with P value < 0.1 were conducted in multivariate logistic regression analysis to identify risk factors associated with the study outcomes and the Hosmer-Lemeshow goodness-of-fit test was used to evaluate the model. P value < 0.05 was considered significant. The above analyses were conducted with IBM SPSS Statistics for Windows, version 27.0.1.

Results

Patients' Characteristics

A total of 2519 patients was included in this study with the median age of 46 years (IQR, 38–56 years). The incidence of preoperative anemia was 30.8% (776/2519), among which 44.4% were mild anemia, 48.0% were moderate anemia, 7.4% were severe anemia. Table 1 presented the patients' basic characteristics, including age, BMI, comorbidity, diagnostic category, surgery grade, surgery duration and volume of blood loss during surgery.

Table 1 Patients' Characteristics

	Anemic (N = 776)	Non-Anemic (N = 1743)	P
Age, years	44 (37, 52)	47 (38, 58)	<0.001
BMI, kg/m^2	23.2 (20.9, 25.5)	23.9 (21.8, 26.6)	<0.001
Comorbidity	201 (25.9)	551 (31.6)	0.002
Diagnostic Category			<0.001
Endometrial/cervical polyp	151 (19.5)	340 (19.5)	
Vaginal bleeding	71 (9.1)	128 (7.3)	
Uterine leiomyoma	145 (18.7)	200 (11.5)	
Adenomyosis	20 (2.6)	24 (1.4)	
Benign ovarian tumor	117 (15.1)	333 (19.1)	
Pelvic floor dysfunction	43 (5.5)	226 (13.0)	
Precancerous lesions	77 (9.9)	206 (11.8)	
Gynecological malignancy	86 (11.1)	166 (9.5)	
Others	66 (8.5)	120 (6.9)	
Surgery grade			0.196
Grade 1	15 (1.9)	18 (1.0)	
Grade 2	327 (42.1)	767 (44.0)	
Grade 3	224 (28.9)	469 (26.9)	
Grade 4	210 (27.1)	489 (28.1)	
Surgery duration, minute	62 (20, 115)	57 (20, 105)	0.056
Volume of blood loss, mL	20 (5, 100)	10 (5, 50)	0.015

Notes: Mann–Whitney *U*-test for continuous variables, χ^2-test for categorical variables.Medians (IQR) for continuous variables, frequencies (%) for categorical variables.
Abbreviations: BMI, body mass index; IQR, interquartile range.

Impacts of Preoperative Anemia on Perioperative Outcomes

In total inpatients, compared with non-anemic group, anemic group had younger age (44 vs 47, P < 0.001), lower BMI (23.2 vs 23.9, P < 0.001) and lower proportion of having comorbidity (25.9% vs 31.6%, P = 0.002) (Table 1); however, it displayed higher incidences of perioperative RBC transfusion (10.7% vs 1.7%, P < 0.001) and complication (4.4% vs 0.9%, P < 0.001), higher hospitalization costs (14531 vs 13681, P = 0.044) and longer LOS (6 vs 5, P < 0.001) (Table 2). The confounding variables identified through univariate regression analysis included age, BMI, comorbidity, gynecological malignancy, surgery duration, and volume of blood loss. After adjusting for confounding variables, lower BMI (aOR = 0.893, P = 0.016), having comorbidity (aOR = 4.422, P < 0.001), preoperative anemia (OR = 6.259, P < 0.001), gynecological malignancy (aOR = 4.376, P < 0.001), longer surgery duration (aOR = 1.010, P < 0.001) and greater volume of blood loss (aOR = 1.002, P < 0.001) were associated with higher incidences of perioperative complication. In addition, lower BMI (aOR = 0.924, P = 0.023), having comorbidity (aOR = 2.702, P < 0.001), preoperative anemia (OR = 15.932, P < 0.001), longer surgery duration (aOR = 1.006, P = 0.003) and greater volume of blood loss (aOR = 1.006, P < 0.001) were associated with higher incidences of perioperative RBC transfusion. (Table 3). The Hosmer-Lemeshow goodness-of-fit test indicated that the logistic regression models performed well (P > 0.05), with the prediction rate exceeding 90%.

Table 2 Comparison Between Anemic and Non-Anemic Groups in Total Inpatients

	Anemic (N = 776)	Non-Anemic (N = 1743)	P
Perioperative transfusion	83 (10.7)	29 (1.7)	<0.001
Preoperative transfusion	33 (4.3)	0 (0.0)	
Intra/post-operative transfusion	66 (8.5)	29 (1.7)	
Perioperative complication	34 (4.4)	15 (0.9)	<0.001
Infection	12 (35.2)	6 (40.0)	
Heart failure	4 (11.7)	0 (0.0)	
Transfer to ICU	20 (58.8)	5 (33.3)	
Intestinal obstruction	2 (5.8)	2 (0.1)	
Thromboembolic events	3 (8.8)	3 (0.2)	
LOS, day	6 (2–8)	5 (2–7)	<0.001
Hospitalization cost, yuan	14531 (5614–23,343)	13,681 (5538–21,514)	0.044

Notes: Mann–Whitney *U*-test for continuous variables, χ^2-test for categorical variables.Medians (IQR) for continuous variables, frequencies (%) for categorical variables.
Abbreviations: ICU, intensive care unit; LOS, length of stay; IQR, interquartile range.

Table 3 Multivariate Analyses of Perioperative Transfusion and Complication

	Perioperative Complication		Perioperative Transfusion	
	aOR (95% CI)	P	aOR (95% CI)	P
BMI	0.893 (0.815–0.979)	0.016	0.924 (0.863–0.989)	0.023
Comorbidity	4.422 (2.078–9.410	<0.001	2.702 (1.586–4.601)	<0.001
Preoperative anemia	6.259 (2.937–13.342)	<0.001	15.932 (8.258–30.740)	<0.001
Gynecological malignancy	4.376 (1.844–10.383)	<0.001	–	–
Surgery duration	1.010 (1.005–1.014)	<0.001	1.006 (1.002–1.009)	0.003
Volume of blood loss	1.002 (1.001–1.002)	<0.001	1.006 (1.005–1.007)	<0.001

Notes: - no statistical analysis. Logistic regression analyses were used.
Abbreviations: BMI, body mass index; aOR, adjusted odds ratio; CI, confidence interval.

The total patients were then divided into non-gynecological malignancy group and gynecological malignancy group according to the final surgery pathology. In patients without gynecological malignancy, the incidence of preoperative anemia was 30.4% (690/2266). Similar to the previous results, anemic group displayed younger age (43 vs 46, P < 0.001), lower BMI (23.3 vs 23.8, P < 0.001), higher incidences of perioperative RBC transfusion (7.5% vs 0.5%, P < 0.001) and complication (1.6% vs 0.2%, P < 0.001) and longer LOS (6 vs 5, P = 0.004) (Table 4). The multivariate analyses showed that, preoperative anemia were related with both perioperative complication (aOR = 5.609, P = 0.012) and perioperative RBC transfusion (aOR = 23.406, P < 0.001) (Table 5).

In patients with gynecological malignancy, the incidence of preoperative anemia was 34.0% (86/253). Compared with non-anemic group, anemic group had lower BMI (22.9 vs 24.5, P = 0.004), higher incidences of perioperative RBC transfusion (36.0% vs 12.6%, P < 0.001) and complication (26.7% vs 7.2%, P < 0.001) and higher hospitalization costs (45968 vs 42196, P = 0.009) (Table 4). The multivariate analyses indicated that preoperative anemia were related with both perioperative complication (aOR = 6.021, P < 0.001) and perioperative transfusion (aOR = 8.813, P < 0.001) (Table 5).

Table 4 Comparison Between Anemic and Non-Anemic Groups in Patients with or Without Gynecological Malignancies

	Non-gynecological Malignancies			Gynecological Malignancies		
	Anemic (n = 690)	Non-Anemic (n = 1576)	P	Anemic (n = 86)	Non-Anemic (n = 167)	P
Age, years	43 (37, 50)	46 (37, 57)	<0.001	52 (43, 63)	57 (49, 63)	0.052
BMI, kg/m^2	23.3 (21.0, 25.5)	23.8 (21.7, 26.6)	<0.001	22.9 (20.9, 25.4)	24.5 (22.4, 26.7)	0.004
Comorbidity	163 (23.6)	466 (29.7)	0.004	36 (41.9)	85 (50.9)	0.173
Surgery duration, minute	50 (20, 98)	44 (18, 92)	0.175	175 (131, 262)	160 (116, 212)	0.064
Volume of blood loss, mL	10 (5, 50)	10 (5, 50)	0.106	225 (100, 400)	100 (50, 400)	0.008
Perioperative transfusion	52 (7.5)	8 (0.5)	<0.001	31 (36.0)	21(12.6)	<0.001
Perioperative complication	11 (1.6)	3 (0.2)	<0.001	23 (26.7)	12 (7.2)	<0.001
LOS, day	6 (2, 7)	5 (2, 7)	0.004	11 (8, 18)	11 (7, 14)	0.185
Hospitalization cost, yuan	12524 (5326, 20,947)	11,787 (5323, 19,439)	0.229	45,968 (37,418, 60,905)	42,196 (30,064, 53,693)	0.009

Notes: Mann–Whitney *U*-test for continuous variables, χ^2-test for categorical variables.Medians (IQR) for continuous variables, frequencies (%) for categorical variables.
Abbreviations: BMI, body mass index; LOS, length of stay; IQR, interquartile range.

Table 5 Multivariate Analyses of Perioperative Transfusion and Complication in Patients with or Without Gynecological Malignancies

	Non-Gynecological Malignancies				Gynecological Malignancies			
	Perioperative Complication		Perioperative Transfusion		Perioperative Complication		Perioperative Transfusion	
	aOR (95% CI)	P	aOR (95% CI)	P	aOR (95% CI)	P	aOR (95% CI)	P
Age	-	-	0.941 (0.913–0.969)	<0.001	-	-	-	-
BMI	0.768 (0.623–0.946)	0.013	0.922 (0.849–1.001)	0.053	-	-	-	-
Comorbidity	5.032 (1.482–17.088)	0.010	5.698 (1.866–11.330)	<0.001	3.533 (1.406–8.978)	0.007	-	-
Preoperative anemia	5.609 (1.452–21.664)	0.012	23.406 (9.029–60.675)	<0.001	6.021 (2.441–14.853)	<0.001	8.813 (3.203–24.248)	<0.001
Surgery duration	1.010 (1.001–1.019)	0.028	1.007 (1.002–1.013)	0.013	1.009 (1.004–1.015)	<0.001	1.003 (0.997–1.009)	0.268
Volume of blood loss	1.002 (1.001–1.004)	0.004	1.006 (1.004–1.007)	<0.001	1.001 (1.000–1.002)	0.032	1.006 (1.004–1.008)	<0.001

Notes: - no statistical analysis. Logistic regression analyses were used.
Abbreviations: BMI, body mass index; aOR, adjusted odds ratio; CI, confidence interval.

Management of Preoperative Anemia

In this study, 11.5% (89/776) of patients took measures to improve preoperative anemia such as: oral iron supplements (n = 26), intravenous iron supplements (n = 35) and RBC transfusion (n = 28). Among which, 43.8% (39/89) had moderate anemia, and 49.4% (44/89) had severe anemia. We found that patients who received iron supplementation or RBC transfusion preoperatively had higher rates of intra/post-operative blood transfusion and complication, compared with those without preoperative blood management (Table 6). Given that most of these patients had comorbidities, lower Hb concentration before surgery, or had malignant tumors, we conducted multivariate logistic regression analyses to mitigate the influence of confounding factors (Table 7). It indicated that preoperative RBC transfusion was a protective factor against perioperative complication (aOR = 0.032, P = 0.017), while the relationship between iron supplementation and perioperative complication remained unclear (aOR = 0.628, P = 0.502). Also, the Hosmer-Lemeshow goodness-of-fit test displayed the good performance of the logistic regression model (P > 0.05).

Table 6 Comparison Between Anemic Patients with or Without Blood Management

	Iron Supplementation (N = 61)	Preoperative RBC Transfusion (N = 28)	Without Blood Management (N = 687)	P *value*
Age, years	43 (40, 50)	44 (32, 50)	44 (37, 52)	0.491
BMI, kg/m^2	22.7 (21.0, 25.0)	23.3 (20.3, 26.4)	23.3 (21.0, 25.5)	0.951
Comorbidity	19 (31.1)	18 (64.3)	164 (23.9)	<0.001
Gynecological malignancy	13 (21.3)	3 (10.7)	70 (10.2)	0.03
Hb concentration before surgery, g/L	89 (78, 96)	68 (62, 74)	109 (103, 115)	<0.001
Surgery duration, minute	73 (27, 154)	70 (62, 74)	60 (20, 112)	0.089
Volume of blood loss, mL	30 (5, 200)	30 (5, 300)	10 (5, 50)	0.018
Intra/post-operative RBC transfusion	12 (19.7)	13 (46.4)	41 (6.0)	<0.001
Perioperative complication	9 (14.8)	2 (7.1)	23 (3.3)	<0.001
Hospitalization cost, yuan	19318 (7013, 32,760)	22,803 (13,069, 32,205)	13,891 (5409, 22,665)	<0.001
LOS, day	7 (4, 11)	8 (6, 14)	6 (2, 8)	<0.001

Notes: Kruskal–Wallis *H*-test for continuous variables, χ^2-test for categorical variables.Medians (IQR) for continuous variables, frequencies (%) for categorical variables.
Abbreviations: BMI, body mass index; Hb, hemoglobin; RBC, red blood cell; LOS, length of stay; IQR, interquartile range.

Table 7 Multivariate Analyses of Perioperative Complication and Intra/Post-Operative Transfusion in Anemic Patients

	Perioperative Complication			Intra- or Post-Operative RBC Transfusion		
	aOR	95% CI	P	aOR	95% CI	P
Age	1.048	1.011–1.085	0.010	-	-	-
BMI	-	-	-	0.850	0.765–0.944	0.002
Comorbidity	-	-	-	2.405	1.132–5.110	0.022
Hb concentration before surgery	0.912	0.875–0.950	<0.001	0.930	0.908–0.952	<0.001
PBM before surgery						
No (reference)	-	-	-	-	-	-
Preoperative RBC transfusion	0.032	0.002–0.539	0.017	-	-	-
Iron supplementation	0.628	0.162–2.441	0.502	-	-	-
Gynecological malignancy	7.287	2.138–24.836	0.002	-	-	-
Surgery duration	1.008	1.002–1.014	0.015	1.012	1.007–1.017	<0.001
Volume of blood loss	1.002	1.001–1.003	0.001	1.006	1.004–1.007	<0.001

Notes: - no statistical analysis. Logistic regression analyses were used.
Abbreviations: BMI, body mass index; Hb, hemoglobin; PBM, patient blood management; RBC, red blood cell; aOR, adjusted odds ratio; CI, confidence interval.

Discussion

This is a single-center, retrospective study of gynecological inpatients, aiming to investigate the incidence of preoperative anemia and its impact on perioperative outcomes. We found that the incidence of preoperative anemia was 30.8% (776/2519), and patients with preoperative anemia displayed younger age and lower BMI. Multivariate logistic regression analyses showed that preoperative anemia was an independent risk factor for perioperative transfusion and perioperative complication. In addition, preoperative anemia prolonged LOS and increased hospitalization costs. The intervention rate of preoperative anemia in our study was only 11.5% (89/776), and common measures included iron supplementation and RBC transfusion. Multivariate logistic regression analyses indicated that preoperative RBC transfusion was a protective factor against perioperative complication.

Our study indicated that the overall prevalence of preoperative anemia among gynecological surgery patients is 30.8%, which was consistent with previous researches.[13] However, unlike previous studies, we found that anemic patients were younger, which might be due to differences in disease patterns. For instance, vaginal bleeding, uterine leiomyoma and adenomyosis predominantly affected women of reproductive age, accounting for 30.4% and 20.2% in the anemic and non-anemic groups, respectively. Conversely, pelvic floor dysfunction was more common in older individuals, accounting for 5.5% and 13.0% in the two groups, respectively. The prevalence of preoperative anemia in patients with malignancy was 34.0%, slightly higher than that in patients without malignancy (30.4%). The research conducted by Kexue Ning et al showed that the prevalence of anemia in patients with gynecological cancer reached as high as 59.06%.[14] The high prevalence of preoperative anemia among malignant tumor patients could be attributed to the following factors: Most malignant tumor patients were in the state of consumption, so that inadequate nutritional intake leaded to deficiencies in hematopoietic precursors (such as iron, vitamin B12, folic acid, etc). Furthermore, malignancy resulted in chronic inflammation that could cause iron-restricted erythropoiesis due to increased levels of hepcidin; the inflammation could also impact the interpretation of ferritin levels.[15]

Consistent with previous studies, our study found that preoperative anemia was associated with higher occurrence of perioperative complication and perioperative RBC transfusion in gynecological inpatients.[5,8,15,16] Olivia W Foley et al conducted a study involving 60017 patients undergoing surgery by gynecologic oncologists and found that, pre-operative anemia had increased odds of infectious complications (OR = 1.16, 95% CI 1.07 to 1.26), thromboembolic complications (OR = 1.39, 95% CI 1.15 to 1.68), and blood transfusion (OR = 5.78, 95% CI 5.34 to 6.26).[8] A multicenter study involving 5,572 patients undergoing gynecological procedures from Canada showed that preoperative anemia was associated with increased ICU admissions and hospital length of stay.[15] A retrospective study of 98813 patients who underwent a laparoscopic hysterectomy for benign indications revealed that, preoperative anemia was identified as an independent risk factor for extended length of stay, readmission and composite morbidity after surgery.[16] These findings unanimously highlighted the importance of implementing patient blood management.

According to the Expert Consensus on Perioperative Blood Management in Gynecological Patients, therapeutic measures of preoperative anemia include oral/intravenous iron supplements, erythropoietin, and treatment of primary disease.[17] In our study, 11.5% (89/776) of patients took measures to improve anemia, among which, 93.3% had moderate to severe anemia. Compared with those without preoperative PBM, patients who received iron supplementation or RBC transfusion preoperatively displayed higher rates of intra/post-operative blood transfusion and complication. It might be explained by the following reasons: (1) Most of those patients had moderate to severe anemia, and the severity of anemia was also correlated with the rate of perioperative outcomes.[16] It had also been confirmed by the results of the logistic regression model (Table 7), displaying that lower Hb concentration before surgery was a risk factor for perioperative complication and RBC transfusion. (2) Consensus stated that oral iron should start at least 6 to 8 weeks before surgery, so the insufficient duration of oral iron supplement might not achieve the goal of improving anemia. As Table 7 showed, preoperative restrictive RBC transfusion can rapidly improve anemia, which appeared to be a protective factor against perioperative complication.

Our findings emphasized the importance of screening and managing anemia before surgery. To integrate preoperative PBM into routine preoperative protocols, we proposed the following approach.[17,18] Routine complete blood counts should be performed during the initial consultation for surgical patients. If it indicated anemia, further tests should be conducted to identify underlying causes such as deficiencies in hematopoietic precursors (iron, vitamin B12, folic

acid), excessive blood loss, or hematologic disorders. An individualized PBM plan should be developed based on the patient's general condition, Hb concentration, cause of anemia, type of surgery, and anticipated blood loss during surgery. For Hb < 70 g/L, RBC transfusion was recommended; for Hb > 100 g/L, drug therapy was employed; for Hb between 70 and 100 g/L, decision depended on specific circumstances.[17] Currently, commonly used medications included oral iron supplements, intravenous iron supplements, folic acid, and vitamin B12, erythropoietin was not routinely recommended. The most common type of anemia in gynecology was iron deficiency anemia. For elective benign surgeries, oral iron supplements for 6–8 weeks should be selected. For emergency or limited surgeries requiring rapid anemia correction, intravenous iron was more recommended. Additionally, anemic patients should adjust their dietary structure, emphasize food diversity and balanced nutrition, and seek guidance from clinical nutritionists when necessary.

Our study had the following limitations: (1) This was a single-center retrospective study, and there might be bias in case selection. (2) Limited to the sample size, the number of perioperative complications is small in some subgroups, which may result in unstable estimates and wide confidence intervals. And the potential for overfitting might exist in logistic regression model. Therefore, we introduced the Hosmer-Lemeshow goodness-of-fit test to evaluate the model. (3) This study was a retrospective study without long-term follow-up, failing to evaluate long-term complications and prognosis.

Conclusion

Preoperative anemia was related to higher incidence of perioperative RBC transfusion and complication, and it increased hospitalization costs and prolonged LOS in gynecological inpatients. PBM before surgery could help improve perioperative outcomes. These findings emphasized the importance of early identification and active management of anemia, which might help reduce transfusion needs, minimize complications, and ultimately enhance gynecological inpatients' outcomes.

Ethics Approval and Informed Consent

Approval was obtained from the Ethics Committee of Peking University People's Hospital. The procedures used in this study adhere to the tenets of the Declaration of Helsinki. The requirement for informed consent was waived because this study didn't involve the subjects' privacy or personally identifiable information and the waiving informed consent wouldn't adversely affect the health and rights of subjects.

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Author Contributions

All authors made a significant contribution to the work reported, whether that is in the conception, study design, execution, acquisition of data, analysis and interpretation, or in all these areas; took part in drafting, revising or critically reviewing the article; gave final approval of the version to be published; have agreed on the journal to which the article has been submitted; and agree to be accountable for all aspects of the work.

Disclosure

The authors declare no financial or non-financial competing interests related to the content of this manuscript. None of the authors have relationships with organizations that might have an interest in the publication, including employment, stock holdings, patents, or consulting fees.

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