Examining the Utility and Cost of Routine Type and Screen Prior to Minimally Invasive Hysterectomy

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ABSTRACT

Background and Objectives: Pre-operative type and screen (T&S) is typically obtained if a patient is expected to require a blood transfusion; however, in cases of minimal blood loss, routine T&S may be unnecessary. The objective of our study was to examine the utility and cost of routine pre-operative T&S prior to minimally invasive hysterectomies (MIH).

Methods: We performed a retrospective chart review of all MIH from January 1, 2018 to December 31, 2019. Patient demographics and surgical parameters were abstracted. The proportion of MIH with a preoperative T&S was compared to the rate of peri-operative blood transfusion. Statistical tests were used where appropriate. Logistic regression was used to examine the relationship between pre-operative hemoglobin (Hgb) and peri-operative transfusion.

Results: Patients (n = 307) with a mean age of 54 (standard deviation = 12.6) underwent MIH. T&S was ordered in 42.7% of cases, with 2.9% requiring a blood transfusion. Two-thirds of women receiving a transfusion had a history of anemia ($p = .004$). Women with a pre-operative Hgb < 10.6 gm/dL (n = 30) had a 27% probability of a transfusion, while those with a pre-operative Hgb > 10.6 gm/dL (n = 264) had a 99% probability of no transfusion. A T&S costs ~$190 at our institution; if routine T&S was eliminated prior to MIH, cost savings is projected to be ~$11,590 annually.

Conclusion: Approximately 42.7% of MIH had T&S ordered, but only 2.9% received transfusions. Most patients who required a transfusion had a history of anemia. Significant cost savings could be incurred if routine T&S was eliminated prior to MIH.

Key Words: Hysterectomy, Laparoscopy, Minimally invasive, Type and screen, Hemoglobin, Cost savings.

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INTRODUCTION

A type and screen (T&S) is a pre-operative lab test ordered for patients who may require a blood transfusion as the first step in verifying donor/recipient compatibility. This lab test identifies the patient's ABO and Rh blood type and screens for any non-ABO antibodies that may have developed against donor red blood cells to allow for proper matching and ensure compatibility. Despite being a common part of pre-operative practice, most patients who have a T&S drawn will not actually require a blood transfusion and routine ordering may result in unnecessary patient burden and costs.

Previous recommendations suggest that T&S is required in patients with a ≥ 5% probability of transfusion based on procedure type.[1] However, as surgical procedures have become less invasive, there is decreased bleeding risk and need for blood transfusion.[2] Literature shows that most patients undergoing minimally invasive gynecologic surgery have minimal blood loss and rarely require a blood transfusion. Ransom (1996) reported that only 0.02% of vaginal hysterectomies (26 of 1063 cases), performed over a 6-year period, needed an intra-operative blood transfusion.[3] In another study, although 72% of the 7,529 laparoscopic procedures, performed over a 3-year period, had a T&S ordered, only 0.7% required transfusion.[4] Similarly, Rayborn et al. reported a 0.2% transfusion rate for 422 robotic hysterectomies performed.[5]

As health care costs continue to increase, there is a general consensus to work towards cost savings in all aspects of patient care. Health care providers and hospitals, as a whole, are charged with the task of finding safe ways to decrease unnecessary spending. With cost control in mind, the utility of certain preoperative tests, such as T&S, has come under scrutiny. Friedberg (2003) suggested T&S may not be necessary in patients with low transfusion risk, achieving a cost savings of $10–78 per T&S.[6] Although the cost of an individual test may be low and vary from hospital to hospital, the cumulative expense can be substantial. One study looking at eliminating routine T&S prior to laparoscopic cholecystectomy estimated a cost savings of $79,800 over a period of 6 years.[7] Furthermore, as minimally invasive hysterectomies are also associated with minimal blood loss and rarely require a blood transfusion, omitting the preoperative T&S may result in significant cost savings.

Despite an increase in minimally invasive gynecologic surgery over the past few years, there are inconsistent guidelines for ordering T&S prior to minimally invasive hysterectomy (MIH). While studies by Ransom et al.[3,4] have brought into question the utility of routine T&S prior to minimally invasive gynecologic surgery, there exists a paucity of data specifically examining the relationship between the use of pre-operative T&S and the rate of blood transfusion amongst various types of MIH. Therefore, our study aims are: 1) to compare the proportion of MIH (laparoscopic and robotic) at our institution that had a preoperative T&S ordered with the rate of blood transfusion in these cases and 2) to calculate the potential cost-savings of omitting T&S testing prior to MIH. Our study also examines the preoperative variables that may impact the decision to order preoperative T&S and perioperative variables that may be associated with blood transfusion.

METHODOLOGY

After Institutional Review Board approval was obtained, we performed a cross-sectional retrospective chart review of all women who underwent a MIH at our institution from January 1, 2018 through December 31, 2019. Patients met inclusion criteria if they had undergone either a laparoscopic or robotic hysterectomy during the study period. Medical charts were reviewed using our electronic medical record (EMR) database. Various pre-operative, intra-operative, and postoperative variables were abstracted. Pre-operative variables included race, ethnicity, age, American Society of Anesthesiologists class, body mass index (BMI), pre-operative hemoglobin, past medical history, past surgical history, and indication for surgery. Past medical history (PMH), included type 2 diabetes, hypertension (HTN), and known anemia. Past surgical history included any prior abdominal or pelvic surgery such as cesarean section, adnexal surgery, cholecystectomy, appendectomy, bowel surgery, or any laparotomy. Indication for surgery included abnormal uterine bleeding (AUB), post-menopausal bleeding (PMB), endometriosis/ pelvic pain, fibroids, adenomyosis, adnexal pathology such as ovarian cysts, cancer (cervical, uterine), pelvic organ prolapse, and stress urinary incontinence. Intra-operative variables included the type of procedure, length of procedure, and estimated blood loss (EBL). Type of procedure was separated into laparoscopic vs robotic, radical vs nonradical, concomitant adnexal surgery, and concomitant additional surgery (such as bowel surgery or sling procedure). Finally, postoperative variables were also collected, which included postoperative hemoglobin level, as well as any complications of the procedure itself. In cases where patients had more than one postoperative hemoglobin listed, we used the hemoglobin drawn on the morning of postoperative day #1 (POD1). Complications included bowel injury, unexpected return to the operating room, abscess or infection, or conversion to an open procedure.

All statistical analyses were completed using IBM SPSS Statistics for Mac, version 26 (IBM Corp., Armonk, NY, USA). Primary outcome measures included the proportion of MIH that had a pre-operative T&S ordered and the rate of peri-operative blood transfusion. Descriptive statistical tests were performed. Data were analyzed using χ^2 tests for categorical variables and Student's t-tests for continuous variables. A binary logistic regression model was used to determine the relationship between pre-operative hemoglobin (Hgb) and peri-operative transfusion status. A receiver operating characteristic (ROC) curve was used to determine the cut-point value of preoperative Hgb to predict the probability of a blood transfusion.

In order to determine the cost of ordering a T&S at our institution, we accounted for the cost of the lab test ($113.39), blood typing ($23.00), determination of ABO Group ($7.39), a lab/draw fee (~$40), and a facility charge (~$40). Therefore, the total cost for one T&S per patient was found to be ~$193.39. To determine cost savings, we calculated the cost of T&S for all MIH cases that did not require a blood transfusion.

RESULTS

During the study period, 307 women, with a mean age of 54 years (standard deviation 12.6), underwent MIH. Demographics are shown in **Table 1**. Most women identified as White/Non-Hispanic (58%). The median BMI was 32 kg/m^2 (interquartile range [IQR] 27, 38). Fifty-eight

Table 1.
Demographics

Mean age, years (Standard Deviation)	54.51 (12.6)
Race, N (%)	
White, Non-Hispanic	175 (57.7)
White, Hispanic	57 (18.6)
Black	62 (20.2)
Asian	11 (3.6)
Multiracial	1 (0.3)
N/A	1 (0.3)
Median BMI, kg/m^2 (IQR)	32 (27,38)
Median ASA status (IQR)	3 (2,3)
Past Medical History, N (%)	179 (58.3)
Hypertension	126 (41)
Anemia	66 (21.5)
Diabetes Mellitus	49 (16)
Past Surgical History, N (%)	
No prior surgeries	127 (41.4)
Prior surgeries	178 (58)
Laparotomy	4 (1.3)
Laparoscopy	20 (6.5)
Myomectomy	5 (1.6)
Cesarean section	75 (24.4)
Tubal ligation	65 (21.1)
Adnexal surgery	29 (9.4)
Pre-operative Hgb, gm/dL (IQR)	13.1 (6.9, 16.3)
Postoperative Hgb, gm/dL (IQR)	11.7 (6.2, 16.3)

BMI, body mass index; IQR, interquartile range.

Table 2.
Operative Details

Service Types, N (%)	
Benign Gynecology	115 (37.5%)
Gynecologic Oncology	174 (56.7%)
Urogynecology	18 (5.7%)
Surgical Indications, N (%)	
Known cancer diagnosis	136 (43.6)
Cervical cancer	17 (12.7)
Uterine cancer	119 (88.8)
Ovarian cancer	2 (14.7)
Benign gynecologic diagnosis	171 (56.4)
Abnormal uterine bleeding	82 (47.3)
Postmenopausal bleeding	13 (7.5)
Adnexal cyst/mass/lesions	23 (13.2)
Fibroids	69 (39.9)
Pain/endometriosis	28 (16.2)
Adenomyosis	8 (4.6)
Pelvic organ prolapse	23 (13.3)
Other indications (breast dysplasia/cancer, BRCA, cervical dysplasia, history of Lynch Syndrome, endometrial hyperplasia)	16 (9.2)
Minimal invasive hysterectomy types, N (%)	
Total hysterectomy	270 (87.9)
Supracervical hysterectomy	30 (9.8)
Radical hysterectomy	7 (2.3)
Median estimated blood loss, cc (IQR)	50 (25,100)
Length of surgery, minutes (IQR)	152 (50,397)

IQR, interquartile range.

percent of women had a history of hypertension, type 2 diabetes mellitus, or anemia, with hypertension most commonly reported (41%). Almost 60% had prior surgeries, with the most common being cesarean section (24.4%) or tubal ligation (21.1%). The median preoperative Hgb was 13.1 gm/dL (IQR 60.9, 160.3) and postoperative Hgb was 11.7 gm/dL (IQR 6.2, 16.3).

Operative details for all cases are shown in **Table 2**. The majority (56.4%) of MIH cases were performed for benign indications: 47.3% for AUB, 39.9% for fibroids, 16% for endometriosis/pelvic pain. One hundred thirty-six cases were performed for known gynecologic cancer, with the majority (89%) performed for uterine cancer. Forty-four percent of cases were robotic-assisted total hysterectomies and 38% were total laparoscopic hysterectomies. Eight percent of MIH cases were supracervical hysterectomies. Median EBL was 50 cc (IQR 25, 100). The median length of surgery was 152 minutes (IQR 50, 397). Out of 307 cases, 279 (90.9%) did not have complications. Twenty-eight out of 307 (9.1%) did have complications, with conversion to an open procedure being the most common (10 cases, 3.3%). Seven cases (2.3%) were complicated by abscess or infection, 3 cases had bowel injuries, and 2 patients underwent cardiac arrest. Less common complications, occurring in only 1 case each, included cystotomy, a return trip to the operating room, bleeding, postoperative small bowel obstruction, and one case in which the patient had both a conversion to open procedure and a small bowel obstruction.

Table 3.
Type and Screen Status

	No T&S ordered, N (%)	T&S ordered, N (%)	p
	176 (57.3)	131 (42.7)	
Mean age, years (Standard Deviation)	54.57 (12.74)	54.44 (12.47)	.931
Race, N (%)			.245
White, Non-Hispanic	108 (61.4)	67 (51.1)	
White, Hispanic	32 (18.2)	25 (19.1)	
Black	28 (15.9	34 (26.0)	
Asian	6 (3.4)	5 (3.8)	
Multiracial	1 (0.6)	0	
N/A	1 (0.6)	0	
Past Medical History, N (%)	89 (50.6)	90 (68.7)	.001
Hypertension	68 (38.6)	58 (44.3)	.321
Anemia	24 (13.6)	42 (32.1)	.001
Diabetes Mellitus	26 (14.8)	23 (17.6)	.510
Past Surgical History, N (%)	105 (59.7)	73 (55.7)	.500
Service Types, N (%)			.103
Benign Gynecology	57 (32.4)	58 (44.3)	
Gynecology Oncology	108 (61.4)	66 (50.4)	
Urogynecology	11 (6.3)	7 (5.3)	
Surgical Indications, N (%)			.242
Known cancer diagnosis	84 (46.6)	52 (39.7)	
Benign gynecologic diagnosis	94 (53.4)	79 (60.3)	
Minimal invasive hysterectomy types, N (%)			.026
Total hysterectomy	161 (91.5)	109 (83.2)	
Supracervical hysterectomy	14 (8.0)	16 (12.2)	
Radical hysterectomy	1 (0.6)	6 (4.6)	

Pre-operative Type and Screen Ordered

Of the 307 cases, 131 (42.7%) had a pre-operative T&S ordered and only 9 (2.9%) required peri-operative blood transfusion (**Table 3**). Most (80%) of the pre-operative T&S were ordered by the primary surgical service, with no significant difference in tests ordered among service types (benign gynecology, gynecologic oncology, or pelvic reconstructive surgery) ($p = .103$). There were no differences in age ($p = .931$), race/ethnicity ($p = .245$), past surgical history ($p = .500$), or surgical indication (oncologic or benign) ($p = .242$) between cases with a T&S ordered and cases without a T&S ordered. A higher proportion (85.7%) of robotic radical hysterectomies had a T&S ordered compared to total laparoscopic or robotic-assisted hysterectomies and supracervical laparoscopic or robotic-assisted hysterectomies ($p = .026$). Significantly more patients with a history of anemia had a T&S ordered compared to those who did not have anemia (32.1% vs 13.6%) ($p = .001$).

Peri-operative Blood Transfusions

While 42% of the 307 MIH cases had a pre-operative T&S ordered, only 9 women (2.9%) required peri-operative blood transfusions. Of the 9 blood transfusions, 1 was given pre-operatively, 2 were given intra-operatively, and 6 were given in the postoperative period. Four patients who received transfusion underwent cases for benign indications and 5 were oncology patients. All 4 benign patients and 2 of the 5 oncology patients had a known history of anemia. Two of the benign cases and 1 of the oncology cases were converted to open hysterectomies. Of the 2 patients who received a blood transfusion intra-operatively, 1 had a starting Hgb of 6.9 gm/dL and the other was converted to an open procedure; neither of these patients had a vascular injury requiring stat transfusion. The mean pre-operative Hgb for the patients that received transfusions was 8.8 gm/dL (6.9–11.8) and 8 out of 9 patients had a Hgb $\leq$ 10.6 gm/dL. Most patients did not have an immediate postoperative Hgb that necessitated transfusion, but ultimately the Hgb downtrended to a point where it was clinically indicated. All 9 of the patients who received a blood transfusion did have a T&S ordered pre-operatively.

Comparing women who required a blood transfusion with those who did not, there was no difference among gynecologic service types ($p = .717$), whether surgery was performed for known cancer or for benign conditions ($p = .736$), or whether the patient had prior surgeries ($p = 1.000$) (**Table 4**). More than half (56%) of women who required a blood transfusion underwent a robotic-assisted (nonradical) total hysterectomy ($p < .001$). Though 6 out of 7 (85.7%) women who underwent a robotic radical hysterectomy had a preoperative T&S ordered, none required a blood transfusion peri-operatively. Two-thirds of patients receiving a blood transfusion also had a history of anemia ($p = .004$). Binary logistic regression was used to determine the relationship between women's pre-operative Hgb levels and the likelihood of receiving a blood transfusion. The odds of a blood transfusion decreased by approximately 71% for every 1 gm/dl increase in preoperative Hgb (odds ratio [OR] 0.293; 95 confidence interval [CI]: 0.16 to 0.47). Using a receiver operating

Table 4. Blood Transfusion Status			
	No Transfusion, N (%)	Transfusion, N (%)	p
	298 (97.1)	9 (2.9)	
Mean age, years (Standard Deviation)	54.46 (12.51)	56.22 (16.29)	.681
Past Medical History, N (%)	171 (57.4)	8 (88.9)	.085
Hypertension	122 (40.9)	4 (44.4)	1.000
Anemia	60 (20.1)	6 (66.7)	.004
Diabetes Mellitus	46 (15.4)	3 (33.3)	.159
Past Surgical History, N (%)	173 (58.1)	5 (55.6)	1.000
Service Types, N (%)			.717
Benign Gynecology	111 (37.2)	4 (44.4)	
Gynecologic Oncology	169 (56.7)	5 (55.6)	
Urogynecology	18 (6)	0 (0)	
Surgical Indications, N (%)			.736
Known cancer diagnosis	133 (44.0)	3 (33.3)	
Benign gynecologic diagnosis	165 (56.0)	6 (66.7)	
Minimal invasive hysterectomy types, N (%)			.892
Total hysterectomy	262 (87.9)	8 (88.9)	
Supracervical hysterectomy	29 (9.7)	1 (11.1)	
Radical hysterectomy	7 (2.3)	0	

BMI, body mass index; IQR, interquartile range.

characteristic (ROC) curve, we also determined the accuracy of identifying a blood transfusion using the pre-operative Hgb value (**Figure 1**). Given two randomly drawn patients from the population (i.e., one without a transfusion and one with a transfusion), the probability of correctly predicting both transfusion statuses given their pre-operative Hgb value is 96% (95% CI: 92%–99%). Further, coordinate points from this ROC curve (**Figure 1**) reveal the optimal pre-operative Hgb value for identifying a transfusion was 10.6 gm/dL. Among patients with a pre-operative Hgb equal to or below 10.6 gm/dL (n = 30), the probability of a transfusion was 27% (95% CI: 12% – 46%). Conversely, among patients with a pre-operative Hgb above 10.6 gm/dL (n = 264), only one experienced a transfusion, making the negative predictive value for this cut off score 99% (95% CI: 98% – 99%).

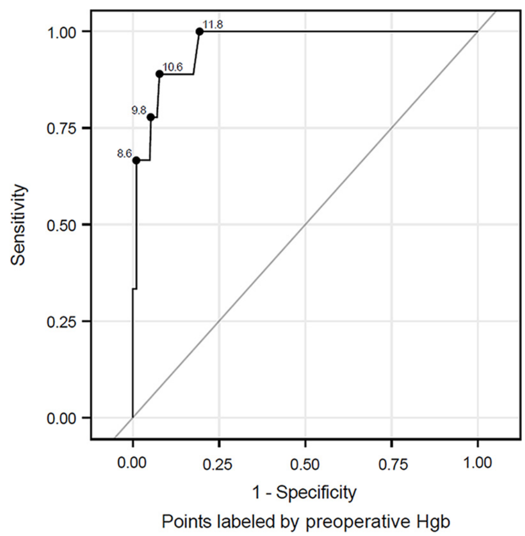

Figure 1. Receiver Operating Characteristic Curve. The Area Under The Curve Represents The Probability Of Correctly Predicting Transfusion Status Based On Pre-operative Hgb Alone.

To calculate cost-savings of eliminating T&S prior to MIH, we determined that the total cost of ordering a T&S at our institution was ~$190. Of the 307 cases, 131 of MIH had a T&S ordered, but only 9 required a peri-operative blood transfusion. If we were to eliminate the 122 T&S tests ordered in MIH cases that did not require a blood transfusion, this would have resulted in a cost savings of $23,180 over our 2-year study period and a predicted annual savings of approximately $11,590.

DISCUSSION

With an increasing number of minimally invasive procedures and the associated decrease in blood loss and risk of blood transfusion, the utility of routine T&S has been questioned across surgical fields. Usal et al. (1999) reported that the incidence of blood transfusion was 12 of 2589 (0.46%) when examining laparoscopic cholecystectomies, and elimination of routine preoperative T&S during the 6-year period studied would have resulted in a total cost savings of $79,800 or approximately $13,300 annually.[7] Although cost savings were not calculated in studies done by Ransom et al.[3,4] evaluating gynecological procedures, low rates of blood transfusion were reported despite the high proportion of routine T&S ordered. Only 0.02% of 1063 vaginal hysterectomies performed over a 6-year period were transfused, and 0.7% of over 7,500 laparoscopic cases, despite 72% of these cases having T&S ordered.[3,4] Friedberg et al. described a cost savings of $10 – $78 per individual T&S lab with the elimination of routine T&S in patients with low transfusion risk.[6] Our findings, in parallel with these previous studies, also suggest that pre-operative T&S may be significantly overordered as the risk of blood transfusion in MIH is low.

Although our blood transfusion rate of 2.9% is low, this is higher than that previously reported in studies by Ransom et al.[3] This is likely due to the limitation that although our study spanned over a 2-year duration and included over 300 minimally invasive hysterectomies, our sample size and the duration of our study period were smaller than that of the previous studies. We chose to limit our study period to the most recent 2 years because though we suspected that the popularity of routine T&S was decreasing with the increasing scrutiny in its utility, T&S were still being ordered at our institution. Given the retrospective nature of our study, we did not examine the time required to obtain a T&S or the difference in time to start a transfusion if a T&S is available or not. Although our study is limited to a single institution's experience, we believe that by including all MIH performed for all gynecological indications and conditions and across the whole spectrum of gynecologic subspecialties, our results are generalizable to most patient populations and other hospitals in various settings.

Despite the limitation of the retrospective nature of our study, we aimed to obtain a comprehensive understanding of the peri-operative variables that may impact the decision to order a pre-operative T&S or those that may increase the risk of a blood transfusion. The median pre-operative Hgb in our study population was 13.1 gm/dL, which is consistent with previously published data examining women undergoing MIH.[8] Understandably, a greater proportion of patients in our study with a history of anemia had a T&S ordered than those who did not have anemia. Likewise, most those who received a blood transfusion also had a history of anemia. This is similar to that found in Usal et al. (1999): of the 33 patients who required a transfusion in 3,192 cholecystectomies, only 2 were transfused after a vascular injury, causing significant intra-operative blood loss; the remainder were transfused as a result of pre-existing causes of anemia.[7]

Furthermore, we examined the relationship between pre-operative Hgb levels and the likelihood of receiving a blood transfusion. Using an ROC curve, we determined that given two randomly drawn patients from the population (i.e., one with and without a transfusion), there is a 96% probability of correctly predicting both transfusion statuses given their preoperative Hgb value. We found that the optimal preoperative Hgb value for identifying a transfusion was 10.6 gm/dL. Specifically, among patients with a pre-operative Hgb equal to or below 10.6 gm/dL, the probability of a transfusion was approximately 1 in 3; while in those with a pre-operative Hgb above 10.6 gm/dL (n = 264), there was a 99% probability of not needing a transfusion. This pre-operative Hgb cut-off value of 10.6 gm/dL may be clinically useful for surgeons during pre-operative counseling in identifying patients who may be at higher risk for needing a transfusion. A retrospective chart review performed by Kane, et al. in 2012 examining hysterectomy for benign disease demonstrated that patients with a pre-operative hematocrit of < 30 were more likely to require a blood transfusion than patients with a hematocrit > 30 (78% vs 25%, OR = 10.6).[9] Other studies have attempted to examine factors and generate predictive models for intra-operative transfusion that could be used to guide pre-operative ordering of T&S. Van Klei et al. (2001) assessed patient characteristics for 1,482 cases deemed at intermediate risk for transfusion (i.e., cholecystectomy or hysterectomy). They found that female gender, age $\geq$ 70 years, and surgery type were independent predictors of transfusion. By scoring patients based on each of these factors and ordering a T&S on those who scored $\geq$ 2 points, 35% of pre-operative T&S could be avoided, at significant savings to the healthcare system. Subsequent elimination of patients when pre-operative Hgb $\geq$ 14 gm/dL reduced testing by an additional 24%, albeit at a cost of 5 missed transfusions.[10] Future studies would be needed to determine whether we can use some variation of these models or our pre-operative Hgb cut off point of 10.6 gm/dL as criteria in selective pre-operative T&S ordering. Others risk factors for intra-operative blood loss could also be examined in an attempt to identify patients at higher risk of requiring blood transfusion who may therefore benefit from T&S. The utility and cost of routine T&S prior to open gynecologic procedures could also be a future area of study.

CONCLUSION

The results of our study support those of other studies previously published in the literature and contribute to the mounting evidence suggesting that pre-operative T&S tests are significantly overordered. Despite almost 43% of all MIH having T&S ordered, less than 3% of patients required blood transfusions. This finding holds true across the spectrum of gynecological indications, conditions, and subspecialties. Our findings that two-thirds of those who required a blood transfusion had a history of anemia suggest that the use of pre-operative T&S prior to MIH could be selective and may be warranted in this patient population, perhaps using a cut off pre-operative Hgb value of 10.6 mg/dL as a criterion. Nevertheless, routine pre-operative T&S prior to minimally invasive hysterectomy may not be cost-effective, and elimination could save thousands of dollars in annual health care costs.

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