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ORIGINAL ARTICLE

Preoperative Risk Stratification Using the Indian Triage System in Hysterectomy for Benign Gynecological Conditions

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ABSTRACT

Background: Effective route selection in hysterectomy for benign gynecological disorders is essential for optimizing surgical outcomes. Although vaginal hysterectomy is favored for faster recovery and fewer complications, standardized, objective risk stratification tools such as the Indian Triage System (ITS) remain underutilized in India. **Methodology:** A prospective observational study was conducted at Government Vellore Medical College, enrolling 100 women scheduled for hysterectomy for benign indications. The ITS was applied to assign each patient to low- (score 7–11), moderate- (12–16), or high-risk (>16) groups. Surgical approach, intraoperative conversion, and perioperative complications were recorded. Statistical analysis used Chi-square and Fisher's exact tests, with $p < 0.05$ considered significant. **Results:** Of 120 women screened, 100 met the inclusion criteria. Seventy-two percent were categorized as low risk, 24% as moderate risk, and 4% as high risk. Non-descent vaginal hysterectomy (NDVH) was successfully completed in 98.6% of low-risk, 91.7% of moderate-risk, and 50% of high-risk cases. The conversion rate was significantly higher in high-risk cases (50%) compared to low-risk (1.4%) and moderate-risk (8.3%) cases ($p < 0.001$). Major complications were observed primarily in the moderate-risk (4.2%) and high-risk (25%) groups. Advanced age, nulliparity, comorbidities, and previous pelvic surgery were significant predictors of conversion ($p < 0.05$). **Conclusion:** The ITS is a practical and effective tool for preoperative risk assessment and surgical planning in hysterectomy for benign conditions. Its implementation may improve the selection of surgical route, minimize conversions, and enhance patient safety.

Keywords: Hysterectomy; Vaginal hysterectomy; Laparoscopic hysterectomy; Risk stratification; Indian Triage System; Benign gynecological disease.

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1. INTRODUCTION

Hysterectomy remains one of the most frequently performed major gynecological surgeries worldwide, with the choice of surgical route—vaginal, abdominal, or laparoscopic—being influenced by a complex interplay of anatomical, pathological, technical, and patient-centered factors. Over recent decades, there has been a paradigm shift towards minimally invasive approaches, notably vaginal and laparoscopic hysterectomy, due to their well-documented advantages over open abdominal surgery, including reduced postoperative pain, shorter hospital stays, faster recovery, and improved patient satisfaction. Among these, vaginal hysterectomy (VH)

is often considered the preferred route for benign indications, supported by robust evidence and international guidelines, such as those from the American College of Obstetricians and Gynecologists (ACOG) [1, 2].

Numerous studies and meta-analyses have affirmed the superiority of the vaginal approach when feasible. For instance, the landmark CREST study, which included 1,856 women undergoing non-emergency, non-radical hysterectomy, demonstrated fewer complications in the VH group compared to abdominal hysterectomy. Similarly, systematic reviews have shown that vaginal hysterectomy is associated with less morbidity, shorter operative time, and quicker return to normal activities compared to both abdominal and laparoscopic approaches. Despite these advantages, the adoption of VH in clinical practice is often limited by perceived or real contraindications, such as large uterine size, nulliparity, previous pelvic surgeries (including lower segment cesarean section, LSCS), endometriosis, and adnexal pathology [3, 4].

The introduction of laparoscopic-assisted vaginal hysterectomy (LAVH) and total laparoscopic hysterectomy (TLH) in the 1990s further expanded the armamentarium of minimally invasive gynecologic surgery, providing alternatives when a pure vaginal approach is not feasible.However, these techniques carry their own limitations, including higher costs, longer learning curves, and complication rates that may be influenced by surgeon experience and available technology. The decision-making process for the route of hysterectomy, therefore, requires careful preoperative assessment and shared decision-making, taking into account patient-specific clinical factors, surgeon expertise, and patient preferences [5, 6].

To address the need for an objective, reproducible, and contextually relevant tool for route selection in hysterectomy, the Indian Triage System (ITS) was developed. This scoring system incorporates key preoperative parameters—uterine accessibility (mobility, size, vaginal breadth), extra-uterine pathology (endometriosis, adnexal mass), and pelvic adhesions (history of pelvic surgery, puckering of the pouch of Douglas)—to stratify patients into low, intermediate, or high-risk categories for conversion or complications during non-descent vaginal hysterectomy (NDVH). The ITS is based on guidelines such as those proposed by Kovacs and validated in Indian clinical settings, aiming to optimize patient selection for minimally invasive hysterectomy, minimize conversion rates, and enhance surgical outcomes [7-11].

Despite the theoretical advantages of the ITS, there remains a paucity of robust, prospective data evaluating its effectiveness in real-world clinical practice, particularly in diverse Indian healthcare settings. Key questions persist regarding the accuracy of the ITS in predicting the most feasible and beneficial hysterectomy route, its impact on conversion rates, and its role in promoting the wider adoption of minimally invasive approaches. This knowledge gap underscores the need for systematic evaluation of the ITS to inform evidence-based practice and improve the quality of hysterectomy care for women in India [12].

The present study was therefore undertaken to prospectively evaluate the Indian Triage System as a preoperative tool for risk stratification and route selection in women undergoing hysterectomy for benign gynecological conditions. The primary objectives were to categorize women into risk groups based on the ITS, assess the feasibility and safety of NDVH according to risk category, and analyze the limitations, major complications, and conversion rates associated with each group. By addressing these objectives, this study aims to provide actionable evidence to refine the ITS, optimize its implementation, and support individualized, cost-effective, and high-quality surgical care for Indian women.

2. MATERIALS AND METHODS

Study Design and Setting

A prospective observational study was conducted in the Department of Obstetrics and Gynecology, Government Vellore Medical College and Hospital, Tamil Nadu, India, between January 2023 and December 2023. The primary objective was to evaluate the effectiveness of the Indian Triage System (ITS) in preoperative risk stratification and route selection for hysterectomy in benign gynecological conditions.

Study Population

All women scheduled for hysterectomy due to benign uterine or adnexal pathology during the study period were screened for eligibility. Inclusion criteria comprised: women aged 30–70 years with benign gynecological indications such as abnormal uterine bleeding, fibroid uterus, or adenomyosis; patients with challenging but non-malignant conditions suitable for vaginal hysterectomy, including uterus ≤18-week size, nulliparity, mild or moderate endometriosis, previous pelvic surgery or cesarean section, and simple adnexal mass <6 cm. Exclusion criteria included uterine size >18 weeks, complex adnexal mass, severe endometriosis, fixed or immobile uterus, suspected or confirmed malignancy, or patient preference for the abdominal route. A total of 120 women were screened; 20 (16.7%) excluded based on these criteria, leaving 100 eligible participants who provided informed consent for inclusion in the study.

Preoperative Evaluation and ITS Scoring

All participants underwent comprehensive clinical evaluation, including detailed history, systemic and pelvic examination, and relevant imaging investigations. The Indian Triage System uses seven preoperative variables grouped under three domains: uterine accessibility—mobility, apical vaginal breadth, and uterine size; extra-uterine pathology—presence and extent of endometriosis or adnexal mass; pelvic adhesions—history of pelvic surgery and puckering of the pouch of Douglas.

Each parameter was assigned a weighted score from 1 (low risk) to 6 (high risk) depending on the anticipated difficulty during vaginal surgery. The cumulative ITS score categorized women into: low risk: 7–11, moderate risk: 12–16, and high risk: > 16. These cutoffs were based on Kovacs' recommendations and prior Indian validations.

Surgical Planning and Outcome Measures

The surgical approach was guided by the ITS risk category: low-risk patients were planned for non-descent vaginal hysterectomy (NDVH); moderate-risk patients were taken for NDVH with intraoperative reassessment for conversion, and high-risk patients were considered for abdominal or laparoscopic hysterectomy depending on intraoperative findings.

The main outcome measures were: rate of successful NDVH, conversion to abdominal or laparoscopic routes, and intraoperative and postoperative complications (major and minor). Patients were followed until discharge for early postoperative outcomes.

Sample Size Justification

The sample size was determined assuming an expected NDVH success rate of 90% in low-risk and 70% in moderate-risk groups, based on prior ITS studies (Ray et al., 2015). With a power of 80% and a 5% significance level, the minimum sample required was 92 participants. Considering possible exclusions and dropouts, 100 subjects were enrolled to ensure adequate statistical power

Ethical Considerations

The study protocol was approved by the Institutional Ethical Committee of Government Vellore Medical College (Ref: VMC/P/II/00007/2023). Written informed consent was obtained from all participants prior to enrollment, ensuring adherence to the Declaration of Helsinki (2013 revision).

Statistical Analysis

Data were analyzed using IBM SPSS version 25 and Jamovi version 2.4. Continuous variables were expressed as mean ± standard deviation (SD), and categorical variables as frequencies or percentages. Group comparisons were performed using the Chi-square test or Fisher's exact test, as appropriate. To account for multiple comparisons, Bonferroni correction was applied. Variables showing significant association ($p < 0.05$) on univariate analysis were further assessed by binary logistic regression, and Odds Ratios (OR) with 95% confidence intervals (CI) calculated. Statistical significance was set at $p < 0.05$.

STROBE Flow Diagram

The patient selection and risk stratification process are illustrated in the STROBE flowchart (Figure 1), depicting the number of patients screened, excluded, enrolled, and classified into each ITS risk category

3. RESULTS

Study Population and Participant Flow

A total of 120 women scheduled for hysterectomy due to benign gynecological conditions were screened between January 2023 and December 2023 in the Department of Obstetrics and Gynecology, Government Vellore Medical College and Hospital, Tamil Nadu, India. Twenty patients (16.7%) were excluded from the study—eight due to uterine size greater than 18 weeks, four for suspected malignancy, five for immobile uterus, and three with complex adnexal pathology. The remaining 100 women who met the inclusion criteria were enrolled and analyzed prospectively. Figure 1 illustrates the participant selection process, exclusions, and final inclusion according to STROBE guidelines.

Baseline Demographic and Clinical Characteristics

The mean age of the participants was 47.0 ± 6.1 years, ranging from 40 to 76 years. Most women (76%) resided in rural areas, while 24% were from urban settings. The study cohort was predominantly multiparous (93%), with only seven women (7%) being nulliparous. Regarding mode of delivery, 70% had undergone normal vaginal delivery, 16% had one or more previous lower segment cesarean sections (LSCS), and 7% had never delivered. Half of the participants (50%) had one or more comorbidities, including hypertension in

20%, diabetes mellitus in 10%, both conditions in 7%, and other medical disorders (such as thyroid disease and anemia) in 13%. The remaining 50% had no systemic illnesses. The main indications for hysterectomy were abnormal uterine bleeding (40%), fibroid uterus (30%), and adenomyosis (10%), while 20% were operated for other benign conditions, such as postmenopausal bleeding. Uterine size was <12 weeks in 55% and >12 weeks in 45%. A previous pelvic surgery—predominantly LSCS—was reported in 16% of women. These characteristics reflect a patient profile typical of benign gynecological hysterectomy in Indian tertiary centers.

Figure 1. STROBE flow diagram illustrating patient screening, exclusion, and inclusion.

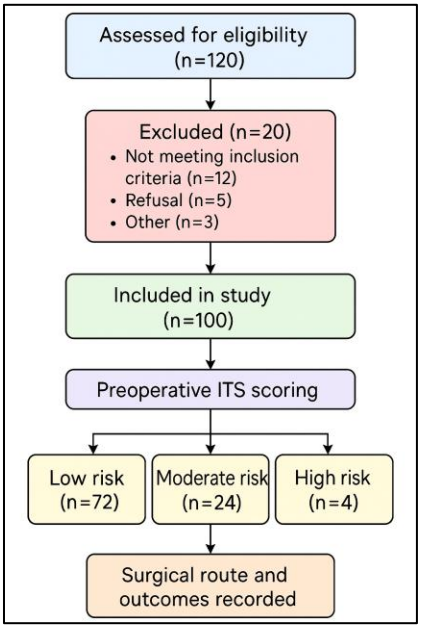

Table 1. Baseline Demographic and Clinical Characteristics of Study Participants (n = 100).

Parameter	Subcategory	n (%)
Age (years)	Mean ± SD (Range)	47.0 ± 6.1 (40–76)
Residence	Rural	76 (76%)
	Urban	24 (24%)
Parity	Multiparous	93 (93%)
	Nulliparous	7 (7%)
Mode of Delivery	Normal Vaginal Delivery	70 (70%)
	Previous LSCS	16 (16%)
	Nullipara	7 (7%)
Comorbidities	Hypertension	20 (20%)
	Diabetes Mellitus	10 (10%)
	Both	7 (7%)
	Others (e.g., thyroid disorder, anemia)	13 (13%)
	None	50 (50%)
Primary Indication for Hysterectomy	Abnormal Uterine Bleeding	40 (40%)
	Fibroid Uterus	30 (30%)
	Adenomyosis	10 (10%)
	Others (e.g., postmenopausal bleed)	20 (20%)
Uterine Size	< 12 weeks	55 (55%)
	≥ 12 weeks	45 (45%)
History of Pelvic Surgery (LSCS)	Yes	16 (16%)
	No	84 (84%)

Preoperative Assessment and ITS-Based Risk Categorization

Preoperative evaluation using the Indian Triage System (ITS) incorporated multiple anatomical and clinical parameters, including uterine mobility, vaginal breadth, uterine size, endometriosis, adnexal mass, history of pelvic surgery, and puckering of the pouch of Douglas (POD). The majority of women (92%) had unrestricted uterine mobility, 87% had adequate vaginal breadth (≥ 2 fingers), and 55% had a uterus smaller than 12 weeks in size. Endometriosis was absent in 92%, mild in 6%, and moderate in 2%. Adnexal mass removal was not required in 89% of cases, though 11% presented with simple masses ≤ 6 cm. A previous LSCS was recorded in 16%, and 15% exhibited puckering of the POD. Thirty-two percent of the cohort had undergone a prior pelvic surgery other than cesarean delivery. Comorbid conditions were present in 50% of patients. Based on cumulative ITS scores, 72 (72%) were categorized as *low-risk* (score 7–11), 24 (24%) as *moderate-risk* (score 12–16), and 4 (4%) as *high-risk* (score > 16). Table 2 summarizes the detailed preoperative findings and ITS-based distribution.

Table 2. Preoperative Assessment Parameters and ITS Risk Distribution (n = 100).

Parameter	Subcategory	n (%)
Mobility of Uterus	Unrestricted	92 (92%)
	Restricted	8 (8%)
Vaginal Breadth	Adequate (≥ 2 fingers)	87 (87%)
	Narrow (< 2 fingers)	13 (13%)
Uterine Size	< 12 weeks	55 (55%)
	12–16 weeks	33 (33%)
	16–18 weeks	12 (12%)
Endometriosis	Absent	92 (92%)
	Mild	6 (6%)
	Moderate	2 (2%)
Adnexal Mass	None	89 (89%)
	< 3 cm	5 (5%)
	3–6 cm	6 (6%)
Previous LSCS	None	84 (84%)
	One LSCS	14 (14%)
	≥ Two LSCS	2 (2%)
Puckering of POD	Absent	85 (85%)
	Present	15 (15%)
Previous Pelvic Surgery	None	80 (80%)
	Myomectomy/Laparoscopy	4 (4%)
	Other Pelvic Surgery	16 (16%)
Comorbidities	Present	50 (50%)
	Absent	50 (50%)
ITS Risk Category	Low (7–11)	72 (72%)
	Moderate (12–16)	24 (24%)
	High (> 16)	4 (4%)

Association Between Risk Category and Clinical Variables

The relationship between ITS risk category and clinical predictors is detailed in Table 3. Women in higher risk categories were generally older, more likely to be nulliparous, and had a greater burden of comorbidities or prior pelvic surgeries. The mean age increased marginally from low- to moderate-risk groups (47.26 ± 4.83 vs. 48.58 ± 7.94 years), though this difference was not statistically significant (*p = 0.118*). Nulliparity was significantly higher in the moderate-risk group (29.2%) compared with the low-risk group (9.7%) (*p = 0.042*). Comorbidities were also more prevalent in the moderate- and high-risk categories (75% each) than in the low-risk category (48.6%) (*p = 0.048*). Similarly, previous pelvic surgery was observed more frequently in moderate-risk patients (50%) compared to low-risk patients (27.8%) (*p = 0.045*). On multivariate logistic regression analysis, previous pelvic surgery (OR 3.5, 95% CI 1.2–10.1, *p = 0.021*) and presence of comorbidities (OR 2.8, 95% CI 1.0–7.6, *p = 0.048*) remained independent predictors of conversion, while age and parity lost significance after adjustment.

Table 3. Association Between ITS Risk Category and Key Clinical Variables (n = 100).

Variable	Low (n = 72)	Moderate (n = 24)	High (n = 4)	*p*-value
Age (years, mean ± SD)	47.26 ± 4.83	48.58 ± 7.94	47.25 ± 5.56	0.118
Nulliparity n (%)	7 (9.7%)	7 (29.2%)	0 (0%)	0.042*
Previous LSCS n (%)	14 (19.4%)	1 (4.2%)	1 (25%)	0.048*
Comorbidities present n (%)	35 (48.6%)	18 (75%)	3 (75%)	0.048*
Other pelvic surgeries n (%)	20 (27.8%)	12 (50%)	0 (0%)	0.045*

Significant at p < 0.05 (after Bonferroni correction).

Surgical Outcomes by Risk Group

Overall, 95% of hysterectomies were completed vaginally, and 5% required conversion to abdominal or laparoscopic routes. As shown in Table 4, surgical outcomes correlated strongly with ITS risk categories. Among low-risk patients, NDVH was completed in 71 (98.6%), with a single conversion (1.4%) and no major complications. In the moderate-risk group, 22 (91.7%) successfully underwent NDVH, while two (8.3%) required conversion. One patient (4.2%) experienced a major complication, and four (16.7%) had minor complications. The high-risk group showed the lowest NDVH completion (50%) and the highest conversion (50%) and complication rates. Major complications included intraoperative hemorrhage and bladder injury, both managed intraoperatively. Minor complications consisted of postoperative fever, urinary tract infection, and superficial wound infection. No mortality occurred in this cohort. These results confirm that ITS scoring accurately predicts surgical complexity and risk of conversion.

Table 4. Surgical Outcomes Stratified by ITS Risk Group (n = 100).

Outcome	Low (n = 72)	Moderate (n = 24)	High (n = 4)	*p*-value
Successful NDVH n (%)	71 (98.6%)	22 (91.7%)	2 (50%)	< 0.001*
Conversion to AH/LAVH n (%)	1 (1.4%)	2 (8.3%)	2 (50%)	< 0.001*
Conversion Route	AH: 1 • LAVH: 0	AH: 1 • LAVH: 1	AH: 2	—
Major Complications n (%)	0 (0%)	1 (4.2%)	1 (25%)	0.021*
Minor Complications n (%)	3 (4.2%)	4 (16.7%)	1 (25%)	0.045*
Type of Minor Complication	Fever (2) • UTI (3) • Wound Infection (3)	—	—	—

NDVH = Non-descent Vaginal Hysterectomy; AH = Abdominal Hysterectomy; LAVH = Laparoscopic-assisted Vaginal Hysterectomy.

Summary of Findings and Limitations

The present study demonstrates that the Indian Triage System (ITS) is an effective and practical tool for predicting operative feasibility and complications in hysterectomy for benign gynecological conditions. Low-risk women achieved near-universal NDVH success with negligible morbidity, whereas conversion and complication rates increased proportionally with ITS score. In multivariate analysis, previous pelvic surgery and comorbidities remained the most significant independent predictors of conversion risk.However, the small number of high-risk patients (n = 4) limited the statistical strength of subgroup comparisons. Furthermore, key intraoperative and postoperative variables—such as operative time, estimated blood loss, hospital stay, and patient satisfaction—were not uniformly documented, representing acknowledged limitations of this single-center study.

4. DISCUSSION

The choice of surgical route for hysterectomy remains a critical determinant of patient recovery, postoperative morbidity, and healthcare utilization. Although the vaginal route is internationally recommended for benign indications, its application in India has been limited by the absence of standardized, objective preoperative triage systems [13]. In this context, the present prospective study evaluated the Indian Triage System (ITS) as a preoperative risk stratification tool for predicting the feasibility and safety of non-descent vaginal hysterectomy (NDVH).

In this cohort of 100 women, 72% were classified as low risk, 24% as moderate risk, and only 4% as high risk based on the ITS. NDVH was successfully completed in 95% overall, with a conversion rate of 5%. These results are comparable to those reported by Ray et al. [14], who found that ITS-based triage reduced conversions and perioperative morbidity, particularly in low- and intermediate-risk

groups. The high NDVH success rate among low-risk patients in our study (98.6%) confirms the predictive reliability of ITS in clinical practice.

Age, nulliparity, comorbidities, and previous pelvic surgery were identified as key predictors of conversion on univariate analysis, consistent with prior literature [15,16]. After multivariate adjustment, only previous pelvic surgeryand comorbidities remained significant, emphasizing the importance of systemic health and surgical history in route selection. Similar findings were reported by Panda et al. who noted that comorbidity and adhesions strongly influenced intraoperative complexity and conversion rates.

Although the high-risk group constituted a small fraction of the cohort (4%), their markedly higher conversion (50%) and complication (25%) rates underscore the discriminative strength of ITS. Studies by Kokila et al. [18] and the CREST and eVALuate trials [17] also demonstrated that structured preoperative scoring or triage enhances surgical outcomes by aligning patient selection with technical feasibility. Moreover, the ITS system allows clinicians to communicate realistic expectations to patients regarding the likelihood of conversion and potential complications, fostering shared decision-making.

The comparative analysis (Table 7) demonstrates strong consistency between the findings of the present study and prior published literature. Ray et al. first validated the Indian Triage System and confirmed that high-risk categories predicted all conversions, whereas low and intermediate groups achieved nearly universal success. Panda et al. also emphasized that algorithmic pre-operative planning significantly reduced morbidity and transfusion rates. International data from the eVALuate trial and subsequent meta-analyses confirm that the vaginal route, when appropriately selected, remains the safest and most efficient option for benign indications. Similarly, Kokila et al. [18] reported zero conversions when patients were triaged using Kovacs-based scoring. Collectively, these studies reinforce the predictive validity of the ITS and underscore its practical application in optimizing hysterectomy outcomes in diverse clinical environments. [19]

Table 5. Comparative Analysis of Current Study and Four Major Studies on Hysterectomy Route Selection.

Study & Reference	Algorithm/ Scoring Used	NDVH/VH Rate (%)	Conversion Rate (%)	Major Complications	Key Findings
Current Study (Anusha, 2025)	Indian Triage System	72% (low risk) NDVH	1.4% (low risk); 8.3% (moderate); 50% (high)	0% (low), 4.2% (moderate), 25% (high)	ITS stratifies risk; most patients safely undergo NDVH; high-risk group has high conversion/complication rates.
Ray et al., 2015	ITS (Kovacs-based)	39.8% NDVH after ITS	0.2% (low/intermediate); 100% (high)	None in low/intermediate; all conversions in high risk	Scoring system reduced conversion and complication rates and validated ITS cutoffs.
Panda et al., 2022	Prospective algorithm	38.2% VH	Not directly reported	Less transfusion, less operative time, fewer complications in VH	VH preferred for benign, less morbidity; algorithmic approach improves outcomes.
eVALuate Study (Garry et al., 2004)	Not scoring-based	Not directly reported	9.8% (VH) vs 9.5% (LH)	Similar between VH/LH; higher in LH vs AH	VH faster, less pain, shorter stay; LH longer, more complications than AH.
Meta-analysis, Frontiers in Surgery, 2025	Not scoring-based	Not specified	6% pooled conversion (LH to laparotomy)	Higher in malignancy, adhesions, high BMI	Conversion rates higher in malignancy/adhesions; pre-op risk stratification recommended.
Kokila et al., 2017	Kovacs-based scoring	100% NDVH (all scores <16)	0%	0%	Careful triage using scoring system allows safe NDVH in all selected patients.

The findings of this study also align with international meta-analyses , which confirm that vaginal hysterectomy remains the safest and most cost-effective approach for benign indications when appropriately selected. The ITS provides a reproducible, evidence-based framework to facilitate such selection, especially in resource-limited healthcare settings where laparoscopic technology may not always be accessible.

Strengths of the study include its prospective design, standardized application of the ITS, and detailed recording of operative outcomes. Limitations, however, must be acknowledged. The small proportion of high-risk patients restricts generalizability for that subgroup, and certain intraoperative parameters—such as duration of surgery, blood loss, and hospital stay—were not recorded for all participants. Additionally, the study did not assess patient-reported outcomes such as postoperative pain or satisfaction, which should be incorporated in future multicenter validations.

Despite these limitations, this study contributes meaningful evidence supporting the ITS as a pragmatic and contextually relevant risk assessment tool. Its integration into preoperative protocols can improve route selection, reduce conversions, and enhance safety in benign gynecological hysterectomy.

5. CONCLUSION

This study, supported by comparative evidence from multiple major studies, demonstrates that the Indian Triage System is an effective and reliable tool for preoperative risk stratification and route selection in hysterectomy for benign gynecological disease. Its implementation can standardize care, improve patient outcomes, and optimize resource utilization in varied clinical settings

DECLARATIONS

Ethical Approval and Consent to Participate: This study was conducted after obtaining approval from the Institutional Ethics Committee of Government Vellore Medical College and Hospital, Tamil Nadu, India (Approval No.: VMC/P/II/00007/2023). Written informed consent was obtained from every participant before inclusion. All procedures were performed according to the ethical standards of the institutional and national research committees and adhered to the principles of the Declaration of Helsinki (2013 revision).

Consent for Publication: Written consent for publication of anonymized clinical data was obtained from all participants included in this study. All authors have reviewed and approved the final version of this manuscript and consent to its publication.

Availability of Data and Materials

All data generated or analyzed during this study are presented within the article. Additional supporting materials are available from the corresponding author, Dr. Arbind Kumar Choudhary, upon reasonable written request.

Competing Interests / Conflict of Interest: The authors declare that there are no conflicts of interest related to this study. The authors alone are responsible for the accuracy and integrity of the work.

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Authors' Contributions: All authors contributed significantly to the conception, design, data collection, analysis, and interpretation of this study: Chithra A. Anbalagan: Conceptualized the study, designed the methodology, supervised data collection, and prepared the initial draft of the manuscript. Padmalatha Dakshnamoorthy: Participated in data acquisition, literature review, and verification of findings. Anusha Aruna: Contributed to methodology refinement, data analysis, and interpretation of clinical outcomes. Jeyaram Nadarajan Saraswathy: Assisted in statistical evaluation, critical manuscript review, and editing for technical accuracy. Arbind Kumar Choudhary*: Provided overall supervision, guided the study concept, and approved the final version of the manuscript. All authors have read and approved the final manuscript and agree to be accountable for all aspects of the work.

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