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Background

Endometrial cancer is the most common gynaecologic malignancy in developed countries and ranks among the top cancers affecting Malaysian women. In 2020, Malaysia was reported among the top 10 countries with the highest incidence and mortality for this cancer.

Accurate staging is critical for treatment planning and prognostication. Traditional lymphadenectomy, while standard for high-risk patients, poses significant surgical risks and morbidity. Sentinel lymph node biopsy (SLNB) offers a less invasive alternative, identifying the first draining lymph nodes to detect metastasis. Among detection techniques, indocyanine green (ICG) combined with near-infrared imaging has shown superior sensitivity and safety.

Laparoscopic ICG SLN mapping may improve staging accuracy while minimizing complications, supporting its potential as a safer and cost-effective option for endometrial cancer management. This technology review was initiated to assess current evidence on its efficacy, safety, and economic value to inform clinical practice in Malaysia.

Objective

The objective of this systematic review and economic evaluation was to assess the effectiveness/efficacy, safety, and cost-effectiveness of laparoscopic indocyanine green sentinel lymph node mapping in endometrial cancer.

Methods

A comprehensive search was conducted on the following databases without any restriction on publication language and publication status. The Ovid interface: Ovid MEDLINE(R) and Epub Ahead of Print, In-Process, In-Data-Review & Other Non-Indexed Citations, Daily and Versions <1946 to April 18, 2025>. Searches were also run in PubMed and Embase. Google was used to search for additional web-based materials and information. Additional articles were identified from reviewing the references of retrieved articles. Eligible studies were identified in accordance with the predefined inclusion and exclusion criteria. Last search was conducted on 24 April 2025. Among the tools used to assess the risk of bias and methodological quality of the articles retrieved is the ROBIS, ROBINS-I V2, RoB 2 and CASP checklist. All full text articles were then graded based on guidelines from the US/Canadian Preventive Services Task Force.

Results and conclusion:

Efficacy/ effectiveness

Based on the above review, there were thirteen studies consisted of three systematic reviews and meta-analysis, two systematic reviews, one non-randomised controlled trial, seven cohort studies retrieved on effectiveness of laparoscopic indocyanine green (ICG) sentinel lymph node mapping for endometrial cancer.

1. SLN Detection and Sensitivity:

- The overall SLN detection rate for ICG was high across various studies, with rates ranging from 88.4% per hemipelvis to 95.6% per patient. Bilateral detection rates varied from 64% to 80%, depending on the cohort.
- Sensitivity for SLN biopsy ranged from 84.2% to 96.4%, with high negative predictive values (NPV) of up to 98.9% in some **studies,** indicating ICG's strong ability to exclude lymph node metastasis.

- False-negative rates were generally low, with most studies reporting figures below 3%.
- Comparison with Systematic Lymphadenectomy (LND):
  Menezes JN et al (2024) demonstrated that while the SLN mapping group had significantly higher rates of minimally invasive surgeries (84.3% vs. 2.9%, p<0.001), the rate of positive lymph nodes was similar between SLN (13.1%) and LND (16.3%) groups (p = 0.18). Importantly, isolated para-aortic metastasis was significantly lower in the SLN group (0.5% vs. 3.3%, p = 0.004).

  Huang L et al (2024) found a low SLN positivity rate of 5.6% in stage IA grade 1/2 endometrioid EC, suggesting that SLN biopsy could be omitted in low-risk cases.

2. Diagnostic Accuracy:
- Several studies highlighted the high diagnostic accuracy of SLN mapping using ICG. The sensitivity for detecting metastasis ranged from 90% to 95%, with some studies achieving 100% negative predictive value for low- and intermediate-risk tumors.

3. Clinical Outcomes and Procedure Efficiency:
- SLN biopsy significantly reduced operative time (median 17 minutes compared to 40 to 70 minutes for full lymphadenectomy) and had no direct complications, as shown in Khemworapong K et al (2024).
- In Gedgaudaite M et al (2022), even in low-experience centers, SLN mapping with ICG proved feasible, with increasing detection rates over time and minimal complications.

4. Technical Comparisons:
- Restaino S et al (2022) compared two near-infrared (NIR) camera systems for SLN mapping. The [redacted] showed slightly higher bilateral detection rates (85.1% vs. 75.7%), although the difference was not statistically significant.

Safety

Laparoscopic SLN ICG mapping is well-regulated across major jurisdictions, with approval from the Malaysia Medical Device Authority, the US FDA, and the European Medicines Agency. Clinical studies consistently show that ICG mapping is safe, with minimal adverse reactions. A large cohort study reported no severe allergic reactions to ICG, while another found no incidents of anaphylaxis. In patients with iodinated contrast allergies, pre-surgical dexamethasone prevented allergic reactions, and no adverse events were observed. Predictive factors for SLN mapping failure include low ICG dose, advanced cancer stage, and enlarged lymph nodes. However, body mass index (BMI) and prior surgeries were not significant factors. Studies on survival outcomes indicate that SLN mapping is not inferior to full lymphadenectomy, with no significant differences in survival or chemotherapy/radiotherapy rates, but the latter was higher in the lymphadenectomy group.

Organisational issues

International guidelines agree on the efficacy of laparoscopic ICG sentinel lymph node (SLN) mapping for low to intermediate-risk endometrial cancer, but variations exist for high-risk cases. Essential organisational challenges include the need for specialised training, near-infrared imaging, and pathology support. Studies on learning curves show that achieving proficiency in SLN mapping requires a significant case volume, with surgeons needing around 30 cases to reach competence in bilateral mapping,

emphasizing the importance of structured training and regular quality assessments to ensure effective adoption and practice.

Economic implication

Three economic evaluations were identified: two cost-effectiveness studies and one cost-analysis. Burg LC et al (2024) demonstrated that SLN mapping using ICG and near-infrared imaging was both more effective and less costly than routine lymphadenectomy in high-risk EC, yielding higher QALYs and lower costs due to reduced complications like lymphoedema. A prior study by the same authors (2021) found SLN mapping to be the most cost-effective strategy for low- and intermediate-risk EC, outperforming both post-operative risk factor assessment and full lymphadenectomy, with robust findings confirmed through sensitivity analyses. Dioun S et al (2021) conducted a retrospective cost analysis in the U.S., showing that SLN mapping and lymphadenectomy incurred higher hospital costs than no nodal evaluation, though SLN mapping offered a less invasive alternative with comparable short-term outcomes.

Conclusion

There were high certainty evidences on laparoscopic ICG SLN mapping which demonstrates its high efficacy in the staging of endometrial cancer. The technique has shown good sensitivity and precision in identifying SLNs, comparable or even superior detection rates compared to conventional methods.

Laparoscopic sentinel lymph node mapping with ICG has better outcomes in terms of morbidity and comparable outcomes in terms of mortality compared to conventional lymphadenectomy in endometrial cancer. No severe allergic reactions or anaphylaxis, no impact on survival or long-term complications were reported. Successful implementation of laparoscopic ICG SLN mapping requires surgeon training and access to near-infrared imaging.

Economic evaluations from high-income country showed that SLN mapping using ICG is a cost-effective alternative to full lymph node dissection in endometrial cancer. Despite higher upfront procedural costs in some settings, long-term models demonstrated lower overall costs and improved outcomes, particularly in high-risk cases, due to reduced complications such as lymphoedema.