CADTH Reference List

Thoracic Surgery and Neurosurgery in the Hybrid Operating Room

March 2023
Key Messages

- We found 6 nonrandomized studies about the clinical effectiveness of thoracic surgery conducted in a hybrid operating room.
- We found 3 nonrandomized studies about the clinical effectiveness of neurosurgery conducted in a hybrid operating room.

Research Questions

1. What is the clinical effectiveness of thoracic surgery conducted in a hybrid operating room?
2. What is the clinical effectiveness of neurosurgery conducted in a hybrid operating room?

Methods

Literature Search Methods

An information specialist conducted a literature search on key resources including MEDLINE, the Cochrane Database of Systematic Reviews, the International HTA Database, the websites of Canadian and major international health technology agencies, as well as a focused internet search. The search approach was customized to retrieve a limited set of results, balancing comprehensiveness with relevancy. The search strategy comprised both controlled vocabulary, such as the National Library of Medicine's MeSH (Medical Subject Headings), and keywords. Search concepts were developed based on the elements of the research questions and selection criteria. The main search concepts were thoracic surgery, neurosurgery, hybrid operating rooms, and hybrid emergency rooms. The search was completed on March 9, 2023, and limited to English-language documents published since January 1, 2018. Internet links were provided, where available.

Selection Criteria and Summary Methods

One reviewer screened literature search results (titles and abstracts) and selected publications according to the inclusion criteria presented in Table 1. Full texts of study publications were not reviewed. The Overall Summary of Findings was based on information available in the abstracts of selected publications.

Table 1: Selection Criteria

<table>
<thead>
<tr>
<th>Criteria</th>
<th>Description</th>
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</thead>
</table>
| Population | Q1: Patients undergoing thoracic surgery  
Q2: Patients undergoing neurosurgery |
| Intervention | Surgery performed in a hybrid operating room |
| Comparator | Surgery performed in a standard operating room |
Criteria | Description
--- | ---
**Outcomes** | Clinical benefits (e.g., postoperative functional status, length of hospital stay, health-related quality of life, patient satisfaction, operative time) and harms (e.g., rates of adverse events, hospital readmission, surgical revisions, complications [e.g., infections])

**Study designs** | Health technology assessments, systematic reviews, randomized controlled trials, nonrandomized studies

**Results**

Nine relevant nonrandomized studies were identified for this report.\(^1\)-\(^9\) Six nonrandomized studies were identified regarding the clinical effectiveness of thoracic surgery conducted in a hybrid operating room (HOR)\(^1\)-\(^6\). Three nonrandomized studies were identified regarding the clinical effectiveness of neurosurgery conducted in a HOR.\(^7\)-\(^9\) No relevant health technology assessments, systematic reviews, or randomized controlled trials were identified.

Additional references of potential interest that did not meet the inclusion criteria are provided in Appendix 1.

**Overall Summary of Findings**

Six nonrandomized studies were identified regarding the clinical effectiveness of conducting thoracic surgery in a HOR, specifically in patients with pulmonary nodules.\(^1\)-\(^6\) The majority of the studies on patients that underwent pulmonary surgery compared intraoperative CT-guided localization in a HOR to preoperative CT localization in a traditional CT room.\(^1\)-\(^5\) Chao et al.\(^2\) observed that intraoperative CT resulted in similar success and complication rates as preoperative CT localization with shorter procedural time and lower radiation exposure. Chen et al.\(^5\) also found that CT-guided localization in a HOR led to similar perioperative and postoperative outcomes with shorter global time when compared to traditional localization in a CT room. Another study concluded that intraoperative CT in a HOR provided shorter time from localization to incision and fewer complications than traditional CT.\(^3\) The same study found similar operation time, blood loss, and length of hospital stay between the 2 groups.\(^3\) Two studies found significantly longer time under anesthesia with intraoperative CT than preoperative CT.\(^2\),\(^4\) Authors of 1 study found cone beam CT-guided localization in a HOR resulted in similar marking accuracy as X-ray guided marking and CT-guided percutaneous injection without causing secondary pneumothorax.\(^1\) One nonrandomized study on thoracic surgery did not specify imaging modality used for localization in HOR, but authors concluded that image-guided lung resection led to decreased time at risk for pneumothorax and risk of hookwire dislodgement compared to standard hookwire localization.\(^6\)

Three nonrandomized studies were identified regarding the clinical effectiveness of conducting neurosurgery in a HOR.\(^7\)-\(^9\) Of these, 2 studies were on patients with brain arteriovenous malformations (BAVM)\(^7\),\(^8\) whereas 1 study focused on patients with severe traumatic brain injuries.\(^9\) One of the nonrandomized studies on BAVM found that neurosurgery in the HOR was effective for the removal high-grade BAVM.\(^7\) The other study on patients with BAVM observed that neurosurgery in a HOR resulted in a lower mortality rate, higher
radiological cure rate, and a higher rate of good outcomes compared to traditional surgery. For the treatment of severe traumatic brain injuries, the hybrid emergency room was significantly associated with a reduction in unfavourable outcomes and time to CT exam and operation compared to conventional treatment. Refer to Table 2 for a detailed summary of all nonrandomized studies included in this report.

**Table 2: Summary of Included Nonrandomized Studies**

<table>
<thead>
<tr>
<th>Study citation</th>
<th>Study design, population</th>
<th>Intervention and comparator(s)</th>
<th>Relevant outcome(s)</th>
<th>Authors’ conclusions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Thoracic surgery</td>
<td></td>
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<tr>
<td>Anamaya et al. (2021)⁴</td>
<td>Study design: Prospective cohort</td>
<td>Intervention: Cone-beam CT and augmented fluoroscopy-guided virtual bronchoscope-assisted injection in the HOR</td>
<td>Secondary pneumothorax</td>
<td>The cone-beam CT and augmented fluoroscopy-guided virtual bronchoscope-assisted injection in the HOR resulted in similar accuracy as comparators without causing secondary pneumothorax.</td>
</tr>
<tr>
<td></td>
<td>Population: Patients with small pulmonary nodules N = 61</td>
<td>Comparator: Percutaneous CT guided injection, X-ray fluoroscopy-guided virtual bronchoscope-assisted injection</td>
<td></td>
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<tr>
<td></td>
<td>Study design: Retrospective study</td>
<td>Intervention: Intraoperative CT guided localization</td>
<td>Procedural efficacy, patient safety, and radiation exposure</td>
<td>The success and complication rates were similar between the two groups. The intervention shortened procedural time and radiation exposure but general anesthesia time for patients was significantly longer compared to the preoperative CT-guided localization.</td>
</tr>
<tr>
<td></td>
<td>Population: Patients with multiple ipsilateral pulmonary nodules N = 54</td>
<td>Comparator: Preoperative CT-guided localization</td>
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<tr>
<td></td>
<td>Study design: Retrospective study</td>
<td>Intervention: Image guided VATs with cone beam CT</td>
<td>Time from localization to incision, success rate, complication rate, operation time, blood loss, and length of hospital stay</td>
<td>Image guided VATs provides shorter time from localization to skin incision with fewer complications than the traditional CT localization. No significant differences were observed in operation methods, operation time, blood loss, and length of hospital stay.</td>
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<tr>
<td></td>
<td>Population: Patients undergoing thoracoscopic lung resection N = 126</td>
<td>Comparator: Traditional CT room localization</td>
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<tr>
<td></td>
<td>Study design: Prospective study</td>
<td>Intervention: Intraoperative CT guided lung tumour localization and resection</td>
<td>Efficacy, safety, and radiation exposure</td>
<td>No difference in localization procedural time and radiation exposure between groups was observed. However, the use of a HOR reduced patient time at risk, as well as increased time under general anesthesia</td>
</tr>
<tr>
<td></td>
<td>Population: Patients with small and deep solitary pulmonary nodules N = 64</td>
<td>Comparator: Conventional 2-stage preoperative CT</td>
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</tr>
<tr>
<td>Study citation</td>
<td>Study design, population</td>
<td>Intervention and comparator(s)</td>
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</table>
| **Chen et al. (2018)**<sup>5</sup> | Study design: Retrospective study study  
Population: Patients undergoing thoracoscopic lung tumour surgery  
N = 308 | **Intervention:** CT guided dye localization in a HOR  
**Comparator:** Preoperative CT guided localization in a traditional CT room | Localization time, global time, success, morbidity rate | CT guided dye localization in a HOR resulted in shorter global time and similar perioperative and postoperative outcomes compared with localization in a traditional room. |
| **Yu et al. (2018)**<sup>6</sup> | Study design: Retrospective cohort  
Population: Patients undergoing thoracoscopic resection  
N = 8 | **Intervention:** Image-guided VATS  
**Comparator:** Standard hookwire localization and VATS | 'At-risk' period for pneumothorax, risk of hookwire dislodgement | Image-guided VATS led to decreased 'at-risk' period for pneumothorax progression and hookwire dislodgement. Standard hookwire dislodgement had a higher risk of hookwire dislodgement. |
| **Quan et al. (2022)**<sup>7</sup> | Study design: Prospective study with historical controls  
Population: Patient with high-grade brain AVMs  
N = 102 | **Intervention:** 1-stop hybrid brain AVM treatment in a HOR  
**Comparator:** High-grade brain AVM patient who underwent surgery | Procedural complications (e.g., hemorrhage, neurological deficit, seizure) | 1-stop hybrid brain AVM is safe and effective for removal of high-grade brain AVMs, especially for patients with diffuse or complex angioarchitecture. |
| **Wen et al. (2019)**<sup>8</sup> | Study design: Retrospective study  
Population: Patient with cerebral AVM  
N = 74 | **Intervention:** hybrid operation (i.e., resection, intraoperative angiography or endovascular embolization)  
**Comparator:** non-hybrid operation. (i.e., microsurgical resection or endovascular embolization, or microsurgery combined with embolization in multiple steps) | Mortality rate, post-operation rehemorrhagia, radiological cure rate, and rate of good outcomes | The hybrid operation resulted in a lower mortality rate, higher radiological cure rate, and a higher rate of good outcomes. Additionally, no patients that underwent a hybrid operation experienced post-operation rehemorrhagia. |
<table>
<thead>
<tr>
<th>Study citation</th>
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</tr>
</thead>
</table>
| Kinoshita et al. (2018) | Study design: Retrospective cohort | Intervention: Treatment in a hybrid emergency room  
Comparator: Conventional treatment | Unfavourable outcomes at 6 months after injury, time from arrival to the start of CT exam and operation | Treatment of TBIs in hybrid emergency rooms was significantly associated with a reduction in unfavourable outcomes and time to CT exam and operation compared to conventional treatment of severe TBIs |

AVM = arteriovenous malformation; HOR = hybrid operating room; TBI = traumatic brain injury; VATS = video-assisted thoracic surgery.
References

Health Technology Assessments
No literature identified.

Systematic Reviews
No literature identified.

Randomized Controlled Trials
No literature identified.

Non-Randomized Studies

Thoracic Surgery

Neurosurgery
Appendix 1: References of Potential Interest

Systematic Reviews

Unclear Comparator


Scoping Review


Alternative Population – Severe Trauma

Non-Randomized Studies

Single Arm Studies


**Review Articles**