Hybrid Operating Room

Introduction

A hybrid operating room (HOR) is a surgical suite that integrates advanced imaging technology with a standard operating room. HOR's are useful for minimally invasive surgeries and more complicated procedures without the need for patient transfers. Originally developed for cardiovascular procedures, HOR combines the imaging capabilities of a catheterization lab with a surgical suite, using Computed Tomography (CT), Magnetic Resonance imaging (MRI) and a fixed C-arm. This setup enhances surgical precision, allows real-time treatment assessment, and saves critical time during emergencies. Proper designing of the HOR ensures optimal workflow and rapid conversion to open procedures when needed. This poster explores the benefits and limitations of HOR's, the costs associated, the various imaging modalities used, and the range of procedures that can be performed in these advanced surgical environments. [1,2]

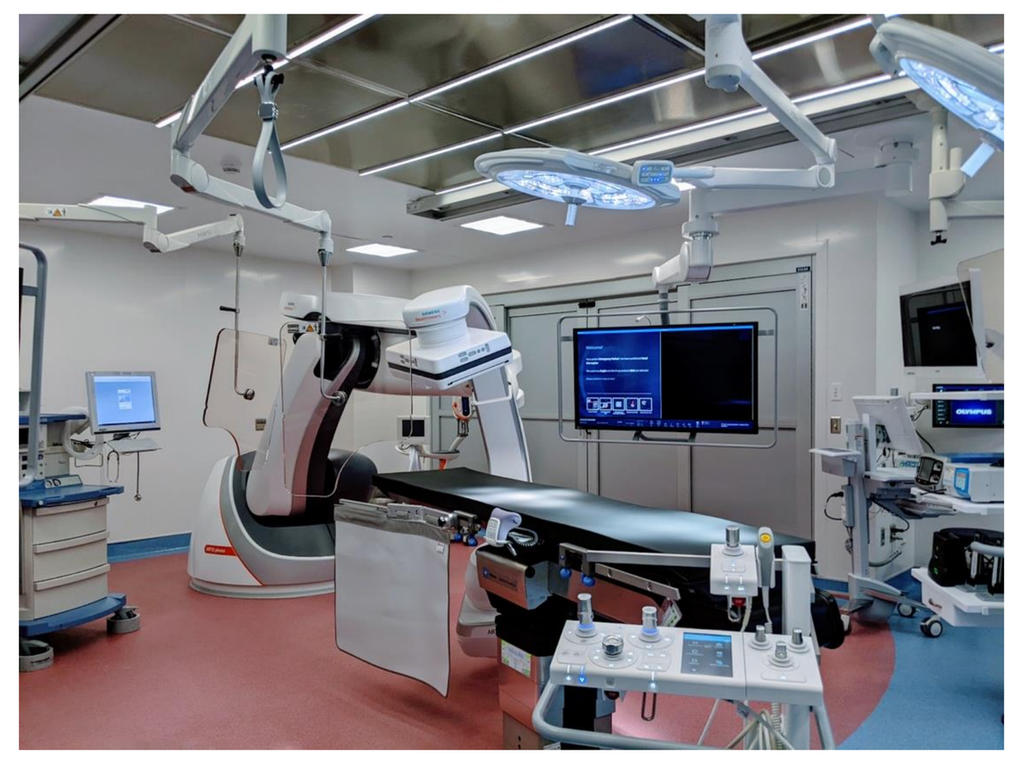

Figure 1: Atlantic Canada's first hybrid operating room [6]

Figure 2: First intraoperative suite in Canada located in Winnipeg featuring MRI [7]

Benefits of Hybrid Operating Room

HORs provide significant advantages by integrating advanced imaging technology into the surgical suite, allowing for more complex procedures and real-time treatment assessments. [2]

Enhanced Imaging & Precision [1]

- Integration of preoperative, intraoperative, and postoperative imaging
- Real-time imaging
- Three- dimensional imaging for surgical planning,

Improved Patient Outcomes [2]

- Smaller incisions, reducing surgical trauma
- Shorter recovery times

Collaborative & Innovative Treatment Approaches [2]

- Enhanced collaboration between surgeons and interventionalists for advanced procedures

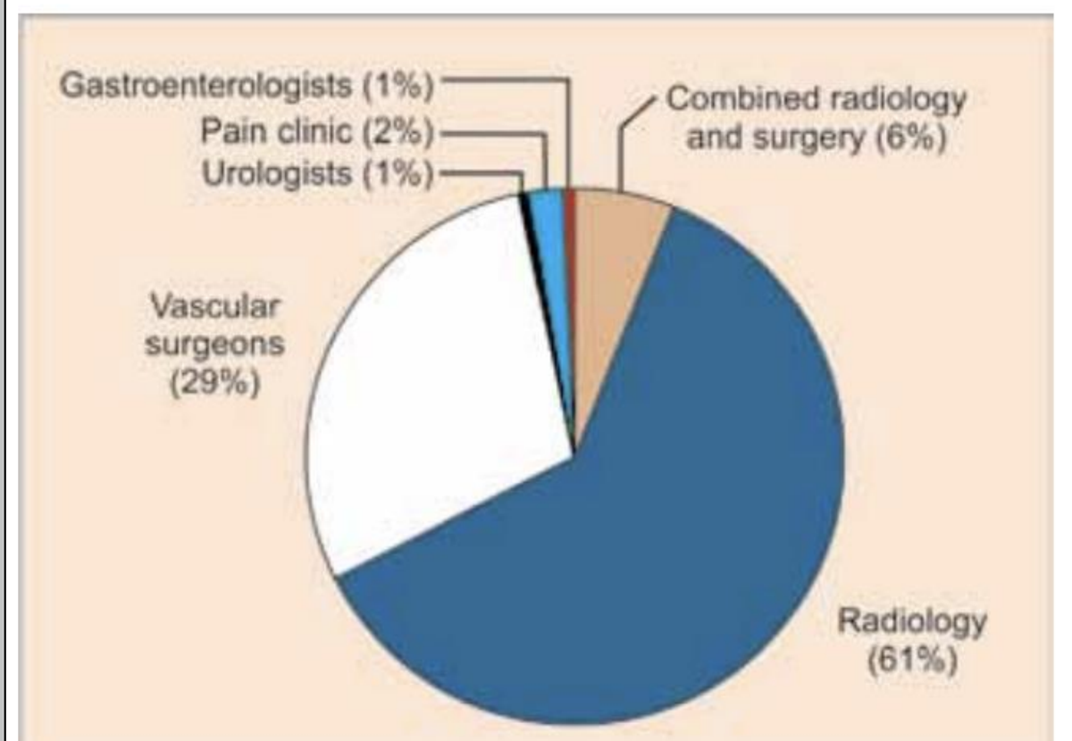

Figure 3: Demonstrating multispecialty usage of the hybrid OR [3]

Figure 5: Collaborative Care Model that improves patient care [12]

Limitations of Hybrid Operating Room

HOR's come with many limitations that can pose significant challenges in optimizing patient care and safety during procedures. [1]

Limited Range of Motion [1]

- Operating room tables and C-arms have restricted movement limiting optimal patient positioning

Radiation Exposure [1,11]

- High risk of radiation exposure during procedures
- Need for radiation protection strategies(lead shielding, distancing, limiting personnel in room, reducing time) and training

Space Requirements [1]

- HOR's require a significant amount of space to fit all the required equipment

Training Requirements [1]

- Surgical teams need additional training to operate the complex technology

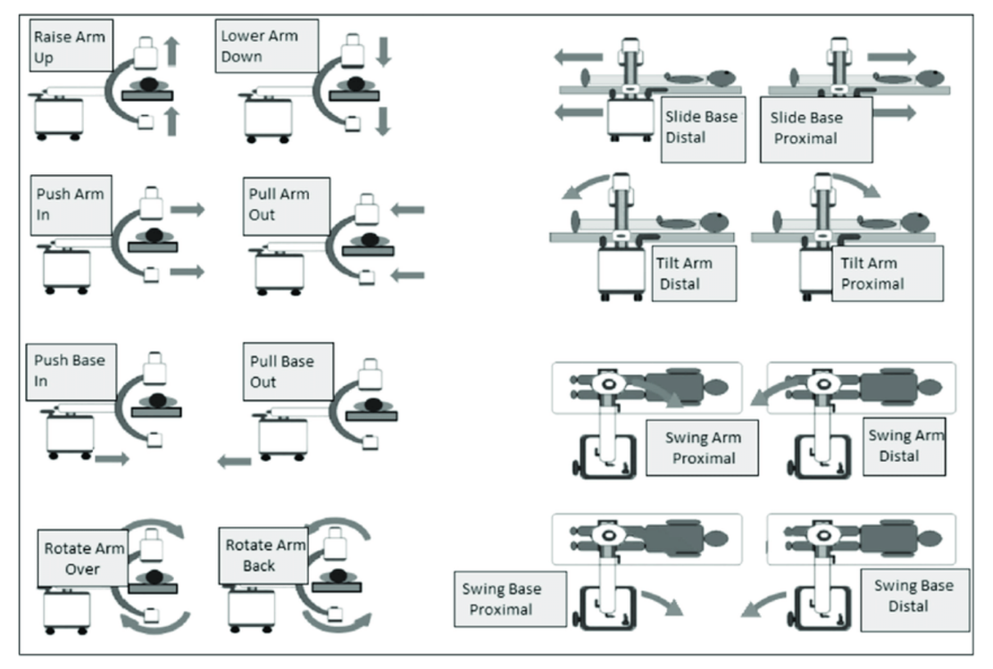

Figure 6: Movements of C-arm [13]

Figure 8: Hybrid OR design [15]

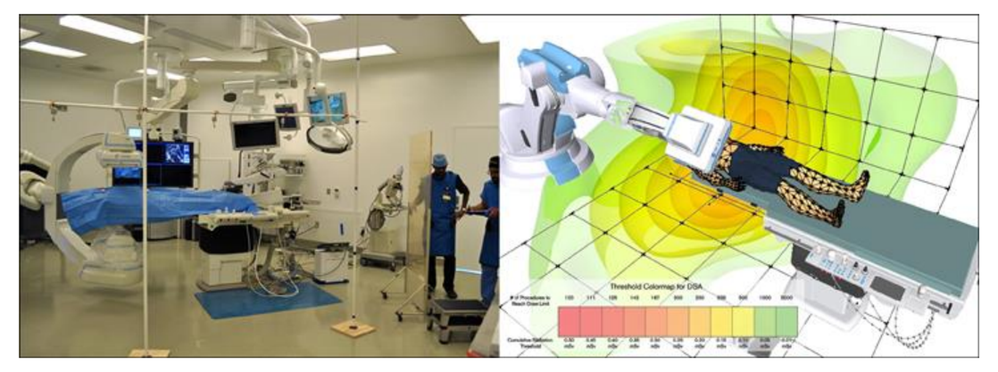

Figure 7: 3D visualization of scatter radiation in a hybrid OR [14]

Cost

Costs of HOR's have some benefits and drawbacks to overall
cost in healthcare facilities. [16]

Versatility in Procedures

- Reduce the need for multiple specialized rooms [16]

High Initial Investment [16]

- Construction costs millions of dollars due to combination of advanced imaging equipment and surgical tools

Maintenance Costs [1, 16]

- Ongoing maintenance and updates

Space Requirements [1, 16]

- large space requirements and additional construction

Training and Staffing [1,16]

- Staff need additional training to operate the new

Figure 9: First Hybrid OR at QEII after $1-million donation by Steward E. Allen [6]

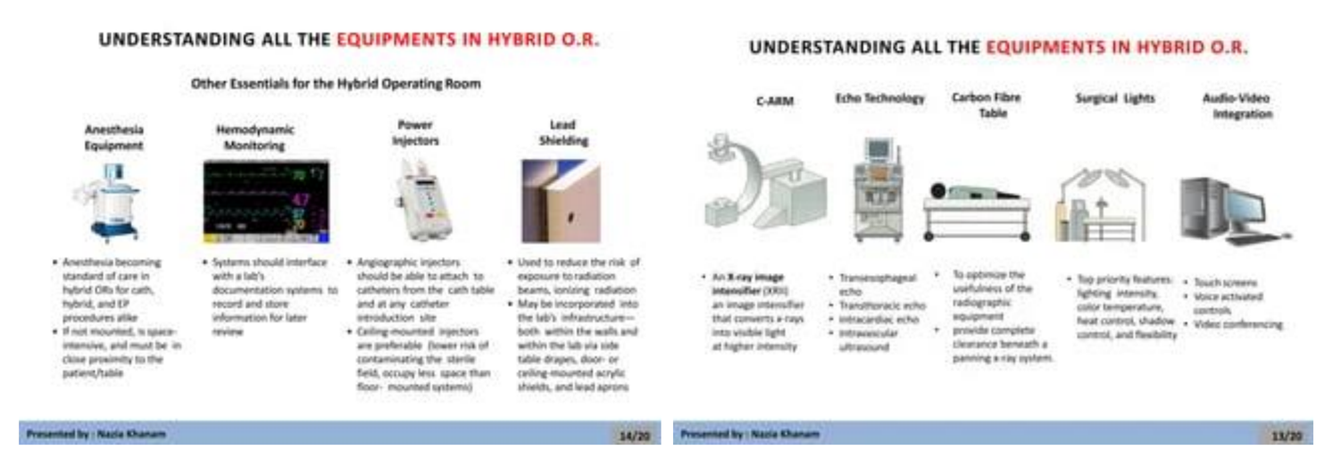

Figure 10: Required equipment for hybrid OR [15]

Different Imaging Modalities

Magnetic Resonance Imaging (MRI)

Overview [3]

- Introduced in 1993, intraoperative MRI is recognized for neurosurgery
- Provides valuable image guidance

Current Challenges [3]

- It's impact on routine neurosurgical practice is still evolving

Challenges [3]

- MRI-compatible instruments and specialized personnel
- RF-shielded operating room
- Significant financial investment for the scanner

Figure 11: Intraoperative Magnetic Resonance Imaging [3]

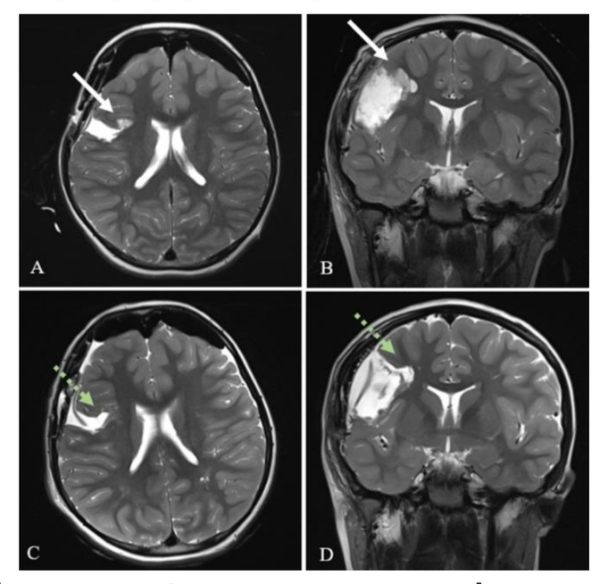

Figure 12: Intraoperative MRI images of a dysembryoplastic neuroepithelial tumor [10]

Computed Tomography (CT)

Advanced Imaging [3]

- 40-multislice CT scanner with a sliding gantry
- Sliding gantry moves over the stationary surgical table

Radiolucent Operating Table [3]

- Carbon-made HOR table accommodates various patient positions

Radiation Safety [3]

- Controlled from an adjacent workstation
- Direct visual and video surveillance
- Personnel remain outside the HOR during scanning

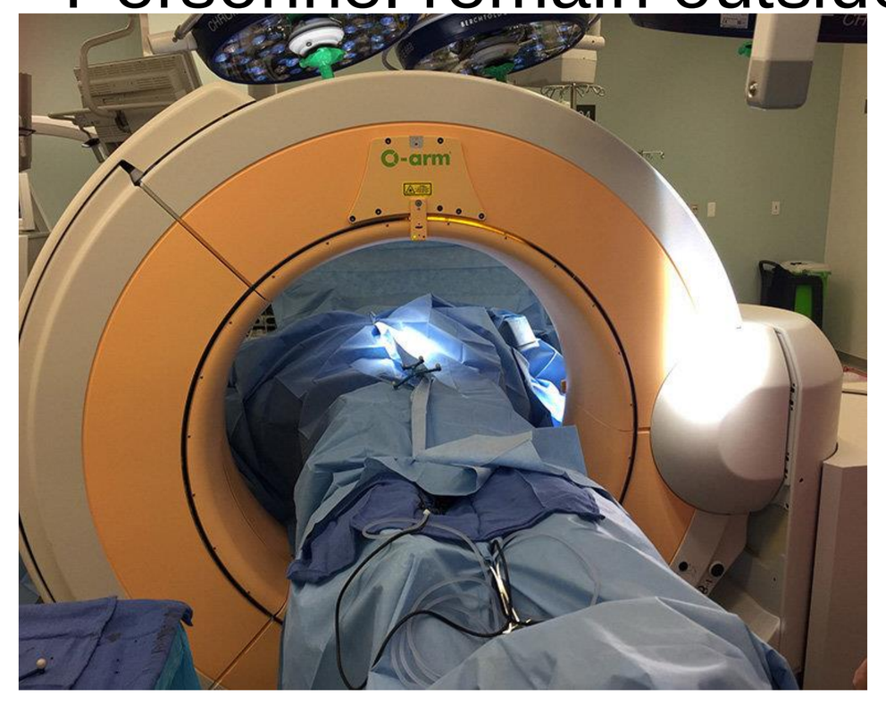

Figure 13: Intraoperative CT of the lumbar spine [9]

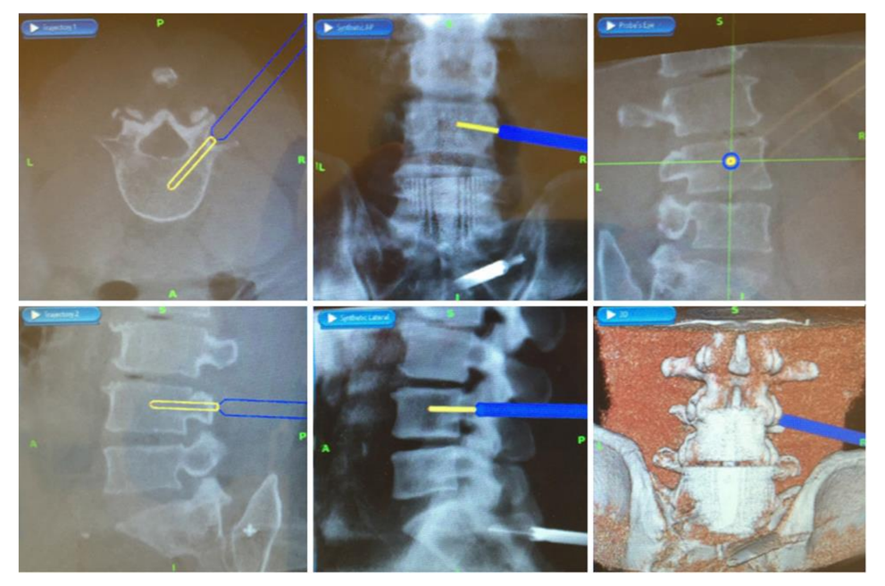

Figure 14: Axial, sagittal and coronal images of the lumbar spine based on the intraoperative CT scan [9]

C-arm

Ceiling-Mounted Systems [4,8]

- Free up floor space
- Parked away when not in use

Floor-Mounted Systems [4,5]

- Avoids ceiling height limitations & airflow interference
- Require dedicated floor space, limiting room space for non-hybrid cases

Advantages [4]

- Better image quality compared to portable systems

Figure 15: Typical setup for a hybrid OR [5]

Different Procedures

HOR's are used for various complex procedures. [1, 18,19,20]

Cardiovascular [18]

- Procedures: transcatheter aortic valve replacement (TAVR), thoracic endovascular aortic repair(TEVAR)
- Real-time imaging allows for navigating and monitoring complex blood vessels

Neurosurgery [1]

- Procedures: cerebrovascular surgery, spinal surgery, and brain tumor resections
- Intraoperative abilities helps confirm exact locations of tumors or lesions and ensures minimal tissue damage

Trauma and Emergency Surgery [19, 20]

- Useful where rapid decision making and diverse surgical techniques may be required
- Ideal for patients with traumatic injuries

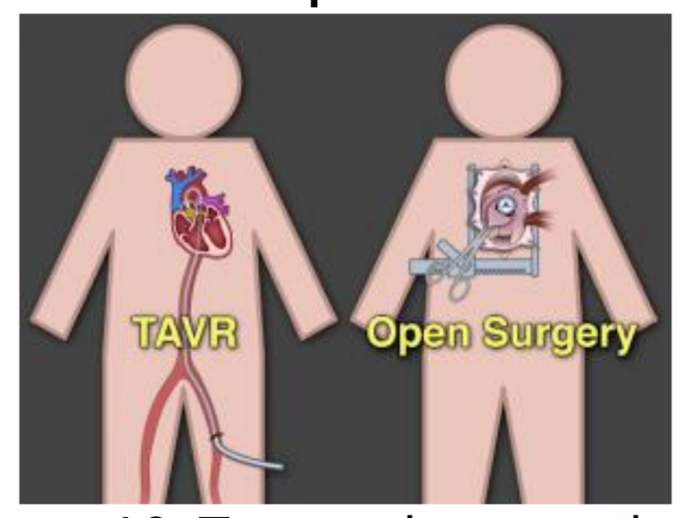

Figure 16: Transcatheter aortic valve replacement(TAVR) vs Open heart surgery [21]

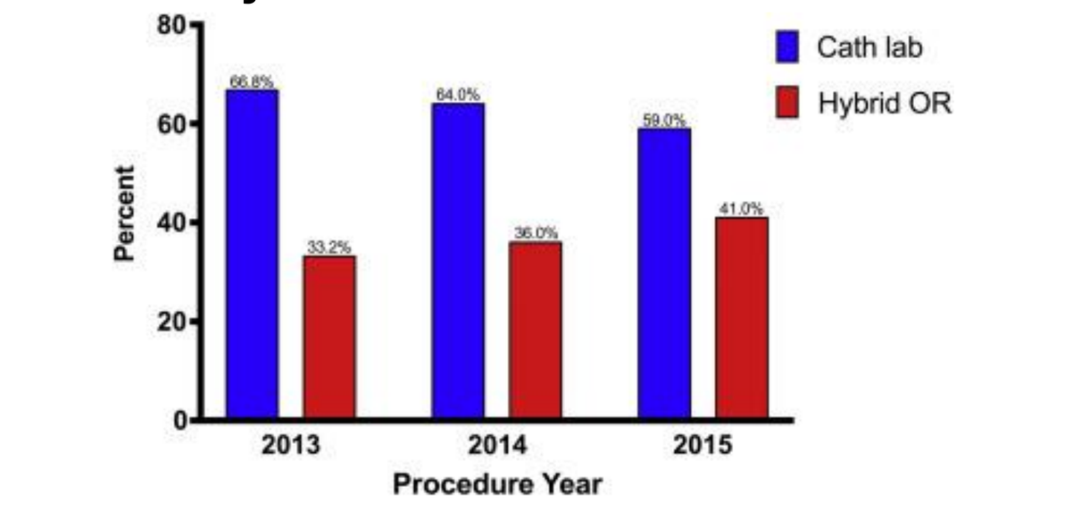

Figure 18: TAVR procedure location comparison [23]

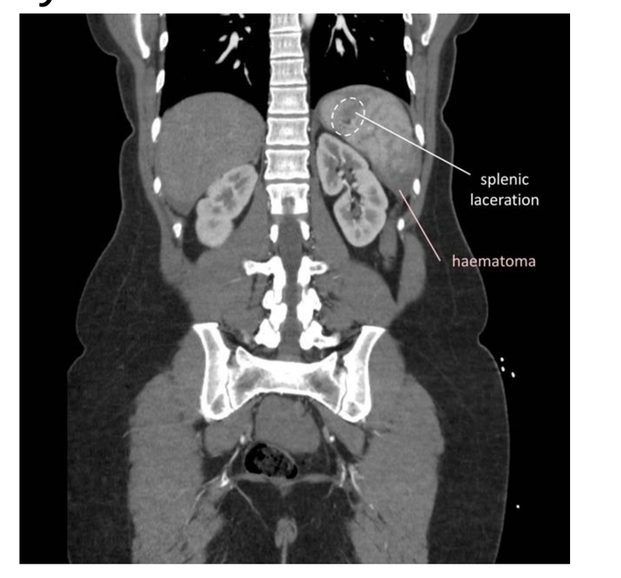

Figure 17: Trauma imaging showing splenic laceration and hematoma[22]

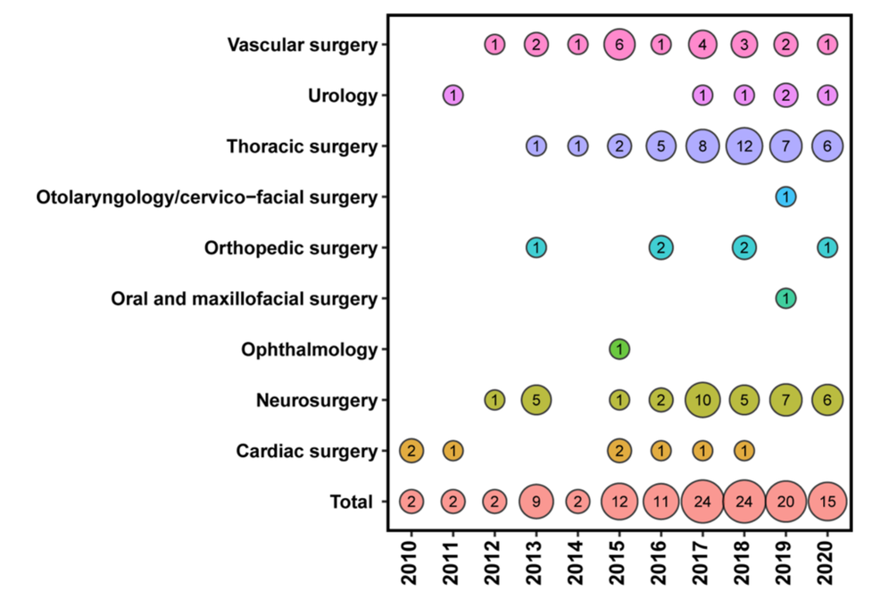

Figure 19: Image-guided procedures in the hybrid OR [2]

Conclusion

HOR's revolutionize modern surgery by integrating advanced imaging technology with traditional surgical suites, enabling real-time treatment assessments, minimally invasive procedures, and improved patient outcomes. These ORs enhance precision, reduce recovery times, and foster collaboration among specialists. However, challenges such as cost, space requirements, radiation exposure, and the need for specialized training must be addressed. Despite these limitations, hybrid ORs play a crucial role in complex procedures, including cardiovascular, neurosurgical, and trauma surgeries, ultimately advancing patient care and surgical innovation.

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[11] Author links open overlay panelJohn Le Heron a, a, b, c, AbstractThe continuing increase in the worldwide use of X-ray imaging has implications for radiation protection of medical staff. Much of the increased usage could be viewed as simply a workload issue with no particular new challenges. However, Protection, I. C. on R., Stoeckelhuber, B. M., & Miller, D. L. (2010, July 24). *Radiation Protection of Medical staff*. European Journal of Radiology. https://www.sciencedirect.com/science/article/pii/S0720048X10003098

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[19] Author links open overlay panelTyler J. Loftus MD, BackgroundEarly hemorrhage control is essential to optimal trauma care. Hybrid operating rooms offer early, Darrabie, M. D., Brenner, M., Kirkpatrick, A. W., Vamvakas, E. C., Alarhayem, A. Q., Yamamoto, R., Peden, M., Kauvar, D. S., Sauaia, A., Hoyt, D. B., Kalkwarf, K. J., Bjerke, H. S., Heetveld, M. J., Agolini, S. F., Ogura, T., Polanco, P. M., Belyayev, L., & Scalea, T. M. (2020, November 20). *Clinical impact of a dedicated trauma hybrid operating room*. Journal of the American College of Surgeons. https://www.sciencedirect.com/science/article/abs/pii/S1072751520325096

[20] Author links open overlay panelMelike Harfouche MD a, a, b, Highlights•Patterns of utilization of the hybrid operating room (hybrid-OR) in trauma have not been adequately described.•This study describes the integration of endovascular and operative interventions in trauma using a hybrid-OR.•The hybrid-OR enables d, ABSTRACTBackgroundPatterns of utilization of the hybrid operating room (hybrid-OR) in trauma have not been described. The aim of this study was to describe the sequencing and integration of endovascular and operative interventions in trauma using a hybrid, Morrison, JJ., Kirkpatrick, A., Kauvar, D., Clarke, J., & Morrison, J. (2021, June 14). *Integrating endovascular and operative intervention in trauma*. Journal of Surgical Research. https://www.sciencedirect.com/science/article/abs/pii/S0022480421002377?fr=RR-2&ref=pdf_download&rr=90944797e8528929

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[23] Author links open overlay panelMarco Spaziano MD, a, b, c, d, e, f, g, h, i, j, k, & AbstractObjectivesThis study sought to compare outcomes of patients undergoing transcatheter aortic valve replacement (TAVR) in a catheterization laboratory (cath lab) to those undergoing TAVR in a hybrid operating room (OR).BackgroundTAVR can be performe. (2018, November 5). *Transcatheter aortic valve replacement in the Catheterization Laboratory versus hybrid operating room: Insights from the France Tavi Registry*. JACC: Cardiovascular Interventions. https://www.sciencedirect.com/science/article/pii/S1936879818313876