Whitepaper

Operational efficiency of the multi-disciplinary hybrid OR

A case study from Yao Tokushukai General Hospital in Japan

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1. Introduction

Over the last 15 years, hybrid operating rooms (ORs) have proven to be an indispensable tool for providing advanced medical care. The obvious benefits of integrating a fixed imaging system in the OR include the ability to plan procedures based on the current intraoperative situation, provide real-time intraoperative guidance, and directly assess the procedure's technical success upon its completion. Hybrid ORs also allow surgical operations to be performed that combine endovascular and open surgeries. In the event of complications, they may improve patient safety by enabling a seamless conversion from endovascular to open surgery.

However, the considerable investment required to install a hybrid OR is a challenge for many medium-sized hospitals, because they typically lack the high volume of specialized procedures that profit most from a hybrid OR, especially cardiovascular surgery. Key questions for many of these institutions include: Is it financially viable to acquire a hybrid OR, and will the medical benefits fully materialize in our case?

In this white paper, we analyze the OR utilization data gathered at Yao Tokushukai General Hospital, a medium-sized private hospital in Osaka Prefecture, Japan. In 2021, the hospital installed a hybrid OR designed for multidisciplinary use, including conventional surgery. Our analysis of this data will demonstrate the success of this strategy in the first four years of the hybrid OR's operation.

The data shows that considerable time savings were achieved in the hybrid OR since 2021, allowing for a substantial increase in the number of cases treated per day. The hospital has also maintained a high utilization rate of the hybrid OR. Finally, the data shows that an increasing number of complex cardiovascular procedures were performed, demonstrating the medical benefits of the hybrid OR for the hospital and its patients. This confirms that a hybrid OR intended for mixed and multidisciplinary use can be a viable and indeed attractive investment for medium-sized hospitals.

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2. General considerations for acquiring a hybrid OR

Since the first installations about 15 years ago, hybrid ORs have transformed the way image-guided and percutaneous procedures are performed [1]. Integrating imaging devices with a multifunctional surgical table achieves more accurate treatment results in minimally invasive surgeries, which have been shown to result in less tissue damage, faster recovery, and lower morbidity and mortality rates compared to open procedures [2]. Hybrid ORs also establish more efficient and better-integrated diagnostic and therapeutic workflows that reduce the risks caused by delays and patient transfers [3].

Early studies on applications in vascular surgery have already shown that using hybrid ORs results in higher precision, greater efficiency, and the ability to perform more complex procedures [4]. These findings have been substantiated by numerous follow-up studies across disciplines, as recent surveys of literature have shown [1, 5, 6]. Hybrid ORs have also proven to be key enablers of minimally invasive procedures, which are one of the most important trends in surgery due to the aging population. Finally, a hybrid OR with its associated benefits enhances an institution's reputation for both patients and prospective staff.

That is why many academic and teaching hospitals and larger institutions in urban areas have already adopted a hybrid OR [5], while numerous other hospitals are considering doing so [7]. Given the growing financial restraints that medical institutions are facing, the high investment required to install a hybrid OR has been a major concern, especially for medium-sized hospitals. They are confronted with the crucial question: Is a hybrid OR financially sustainable for us?

2.1 Cost comparisons for complex procedures

Several early studies have sought to answer this question by comparing the costs of open versus minimally invasive surgical techniques for specific procedures like endovascular aortic repair (EVAR) [4], thoracic endovascular aortic repair (TEVAR) [8], transcatheter aortic valve replacement (TAVR) [9], and lumbar spinal fusion [10]. The studies indicated that the higher cost of hybrid OR treatment in these cases can be offset by greater efficiency in the OR, reduced perioperative and postoperative hospitalization, and fewer complications.

However, this argument does not resolve the economic concerns of institutions that do not perform a high volume of complex procedures and therefore cannot utilize a hybrid OR to capacity with these special cases. For these hospitals, it is essential to take a broader view and carefully consider the operational key performance indicators of the hybrid OR to ensure that it can optimally serve the community as well as support the institutions' financial success.

2.2 Utilization rate as a key factor

One of the fundamental axioms of healthcare economics is that initial investments and fixed costs should be distributed across as many cases as possible in order to increase the contribution margin of each procedure: i.e., the revenue generated once the construction, inventory, personnel, and overhead costs have been deducted [11]. The general need to mitigate OR costs with a high utilization rate is especially important for hybrid ORs [12].

Esposito et al. therefore argue that "the possibility of spreading the initial costs is linked to the amount of procedures for which the hybrid room is intended" [13]. However, their conclusion that this makes hybrid ORs "clearly more advantageous for high-volume surgical procedures centers" may no longer be entirely accurate if the essential high occupancy rate is not exclusively ensured by "all the surgical specialties of the cardiovascular district" [13].

Although cardiovascular surgery was the first medical field to make extensive use of the features of hybrid ORs and still dominates their use, orthopedic trauma surgery [14] and neurosurgery [6] have followed suit. More and more disciplines, including thoracic surgery [3, 6], gynecology, and urology [5], are also now successfully exploring the potential applications of image-guided procedures and have begun claiming their share of time in hybrid ORs.

2.3 Multidisciplinary approach

These developments keep utilization rates high and strengthen the concept of a hybrid OR as a high-end facility that can be shared across disciplines in order to augment treatment options throughout the hospital – rather than installing it as a single department's exclusive asset that performs a high volume of complex procedures. This approach sees the hybrid OR not as an OR designed for procedures that require fixed imaging systems but as an OR that can be used by all clinical departments and contains fixed imaging systems.

Taking such a multidisciplinary approach to the hybrid OR also facilitates the step towards its mixed use for both image-guided and conventional procedures. Performing a limited number of non-hybrid surgeries in the hybrid OR can contribute to keeping its utilization rate high enough to make it financially viable.

3. Technical background and objectives

This white paper analyzes the utilization data collected at Yao Tokushukai General Hospital, a 415-bed facility that serves the community of Yao City in Osaka, Japan. The hospital installed a hybrid OR with a robotic ARTIS pheno C-arm from Siemens Healthineers in February 2021.

Figure 1:
Surgery in the hybrid OR at Yao Tokushukai General Hospital

A monitoring system that includes a network video recorder (NVR) and a surgery management system (Opera Master®, HOGY Medical Co., LTD, Japan) was used to document detailed statistics from the procedures conducted in the hybrid OR since its installation. The system has collected data on the medical departments involved, the types of procedures performed, and time codes for the key stages like admission, start of anesthesia, start of procedure, end of procedure, end of anesthesia, and exit time. It also documented time between cases and idle time. Statistics collected since operations started in the hybrid OR in February 2021 up to August 2024 were available for analysis for this white paper [data on file].

This database can be used to analyze a number of operational KPIs in order to answer the questions posed in this paper, and we will specifically examine the following:

- How has the multidisciplinary use concept developed by Yao Tokushukai General Hospital worked in practice?
- Can turnaround and preparation time be reduced over the long run to improve the efficiency of hybrid OR use, and can this result in an increase in cases treated?
- What is the utilization rate of the hybrid OR?

Additionally, the database also enables a close examination of cardiovascular surgery to determine if the anticipated number of complex procedures – for example, the treatment of abdominal aortic aneurysm (AAA) and thoracic aortic aneurysm (TAA) – has materialized in the hybrid OR.

4. Findings

4.1 The multidisciplinary and mixed-use concept
One of the key decisions made at Yao Tokushukai General Hospital was to ensure that the hybrid OR could be used for both image-guided and conventional surgical procedures. To achieve this goal, the overall layout of the hybrid OR was kept as similar as possible to the other ORs, including a standard OR table that can be used for almost all surgical procedures. Installing the fixed robotic C-arm ARTIS pheno also ensures easy access to the patient at all times.

In addition to the mixed-use concept, the hospital also wanted to make the hybrid OR available for shared use by all disciplines. How well this twofold strategy has worked in practice is reflected in the operational data collected since the installation of the hybrid OR.

From February 2021 to August 2024, the hospital maintained an image-guided use rate of roughly three-quarters of the total procedures performed (between 73.8 and 77.2%). Approximately one-quarter of the operations performed in the hybrid OR were conventional surgeries. The hospital also assigned different days of the week to different clinical disciplines for the OR's primary use: three days for cardiovascular surgery and one day each for orthopedics and neurosurgery, with other disciplines such as Ear, Nose, and Throat (ENT), general surgery, and gynecology filling the gaps [Fig. 2].

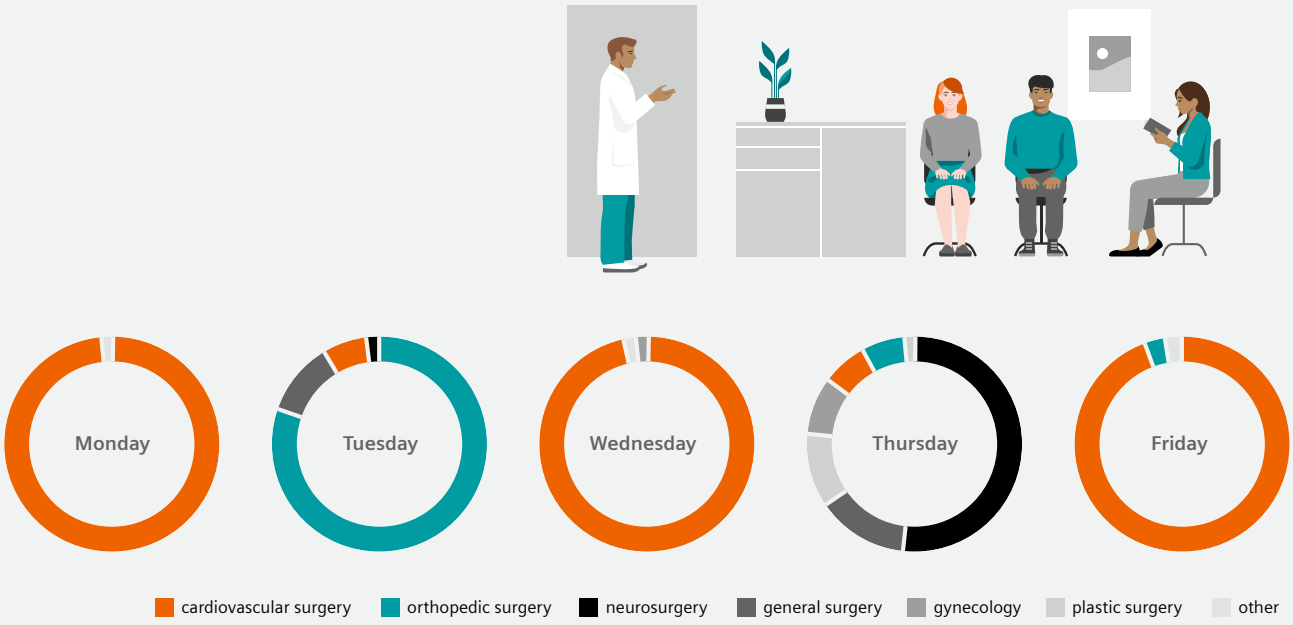

Fig. 2:
Percentage of hybrid OR usage by discipline for the different days of the week

In absolute numbers, cardiovascular surgery dominated, accounting for between 70 and 75% of all procedures [Fig. 3]. Given the great importance of image-guided endovascular procedures in this field, this is not surprising. However, the statistics also show that general surgery, neurosurgery, and orthopedics have consistently claimed a significant share of hybrid OR time and have performed substantial numbers of operations there. This demonstrates the early acceptance of the hybrid OR across disciplines and the ongoing success of the multidisciplinary use concept.

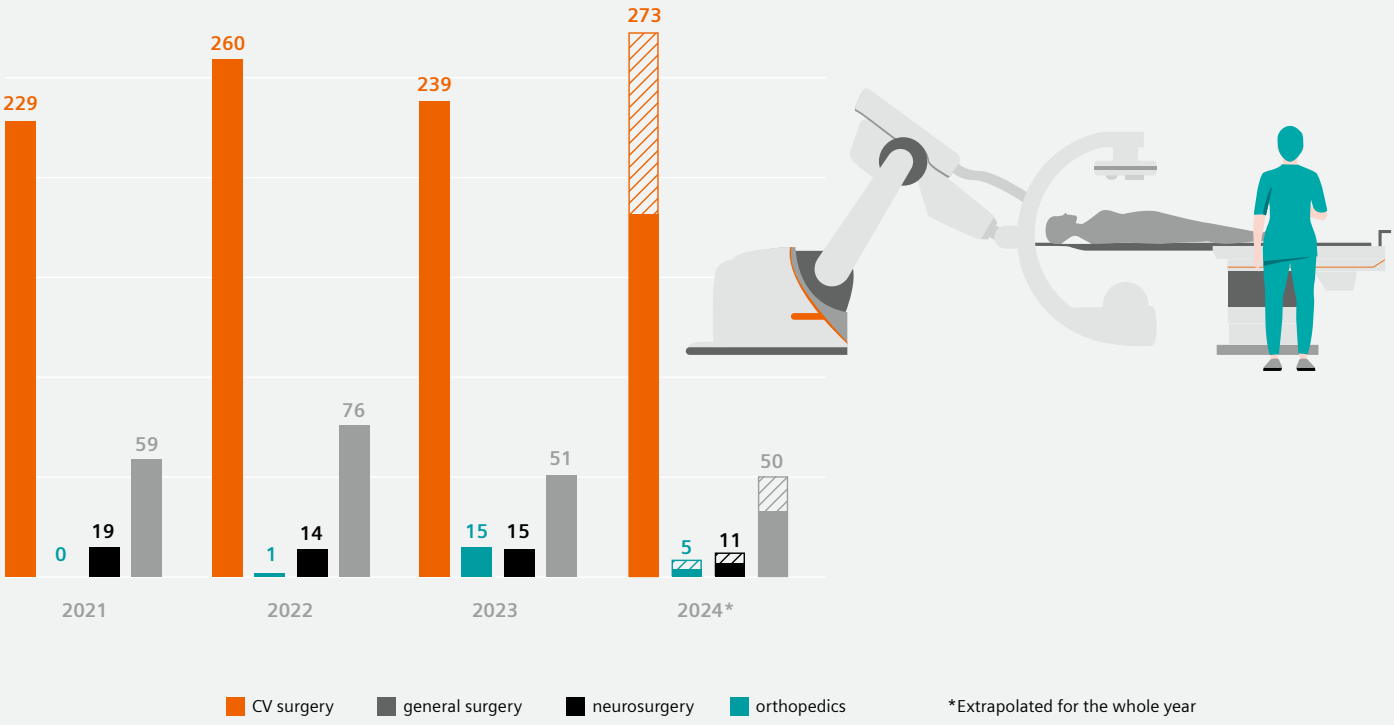

Fig. 3:
Absolute numbers of procedures for different disciplines

4.2 Improved efficiency

The data from Yao Tokushukai General Hospital also shows that the utilization of the hybrid OR has become more efficient over time. The average turnaround time decreased from over 41 minutes in 2021 to between 35 and 37.5 minutes in 2023/24. Case preparation time dropped even more substantially, from over 64 minutes in 2021 to under 56 minutes in 2024 [Fig. 4].

This reflects the increasingly confident use of the hybrid OR with more and more efficient preparation and cleaning routines. This time gain has resulted in a 5.5% increase in the number of hybrid OR cases treated per day (up from an average of 1.46 in 2021 to 1.54 in 2024).

4.3 Utilization rate

The multidisciplinary and mixed-use concepts and the increase in cases treated in the hybrid OR have contributed to a consistently high occupancy rate of between 68 and 78%. This exceeds the 48% mean utilization rate of hybrid ORs in general, as reported by Patel et al. [15]. In that study, the hybrid OR utilization rate was as low as 14% in one case, while the lowest utilization rate of a conventional OR was 87%. This illustrates that the utilization rate of the hybrid OR at Yao Tokushukai General Hospital is comparable to the rates of some conventional ORs, indicating its cost-effective use with a substantial contribution margin.

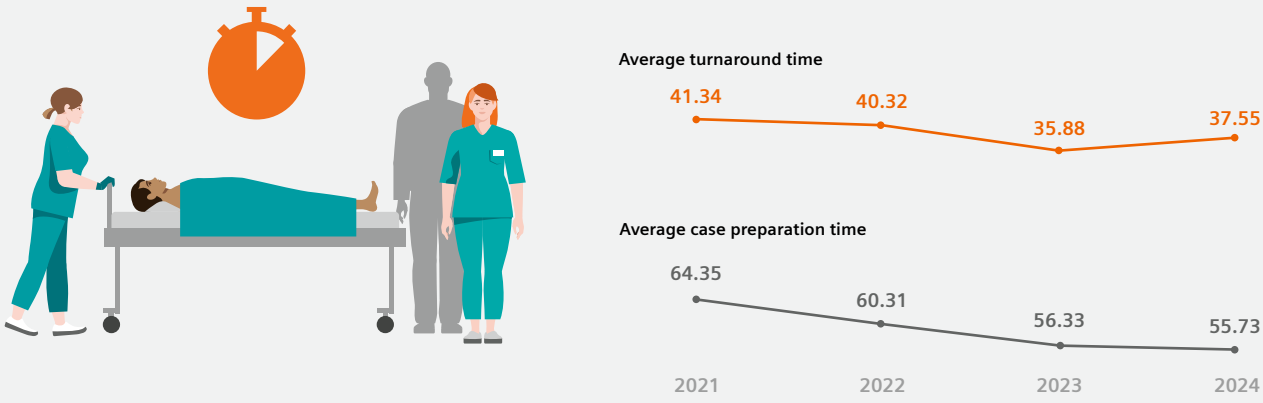

Fig. 4:
Development of turnaround time and case preparation time in seconds

4.4 Increase in complex cardiovascular surgery procedures

An analysis of the individual procedures performed in the hybrid OR and their level of complexity shows that the number of highly complex procedures at Yao Tokushukai General Hospital has steadily increased since the installation of the hybrid OR. While only 110 minimally invasive aortic surgeries were performed in 2021(AAA, TAA, and aortic arch grafts), the number increased to 121 in 2023. In the first eight months of 2024, a total of 101 aortic surgeries were performed. Extrapolating this figure for the entire year, this amounts to more than 151 cases, which is a 38% increase since 2021 [Fig. 5]. In contrast, the number of less complex artery surgeries like thrombectomies has remained relatively stable. These results demonstrate that the anticipated increase in complex procedures associated with the installation of a hybrid OR has been realized at Yao Tokushukai General Hospital. This contributes substantially to the investment paying off in both medical and financial terms.

4.5 Financial indicators

As a private medical institution, Yao Tokushukai General Hospital doesn't publish financial and operational data from its surgical operations. However, the hospital generously provided us with key operational and financial data collected for several months before and two years after the installation of its hybrid OR. Before the installation, the hospital operated seven traditional ORs where an average of 450 surgeries were performed per month. After installing the hybrid OR, the total number of surgeries at the hospital varied between 428 and nearly 600 cases per month, with an average of 504 in the first year and 550 in the second year (a 12% and 22% increase, respectively) thanks to the operational capacity added by the hybrid OR.

Before installing the hybrid OR, the hospital's surgery-related revenue ranged from approximately 250 million to 300 million yen (1.65 to 1.96 million US$) per month, with an average of 278 million yen (1.82 million US$). After installation, that revenue ranged from 306 million to 386 million yen (2 million and 2.53 million US$) per month, with an average of 336 million yen (2.2 million US$) per month in the first year and 350 million yen (2.3 million US$) per month in the second year, indicating a 20.9% and 25.9% increase, respectively. These figures reflect the increase in operational capacity and an increase in average revenue per surgery achieved by implementing the multi-disciplinary hybrid OR at Yao Tokushukai General Hospital.

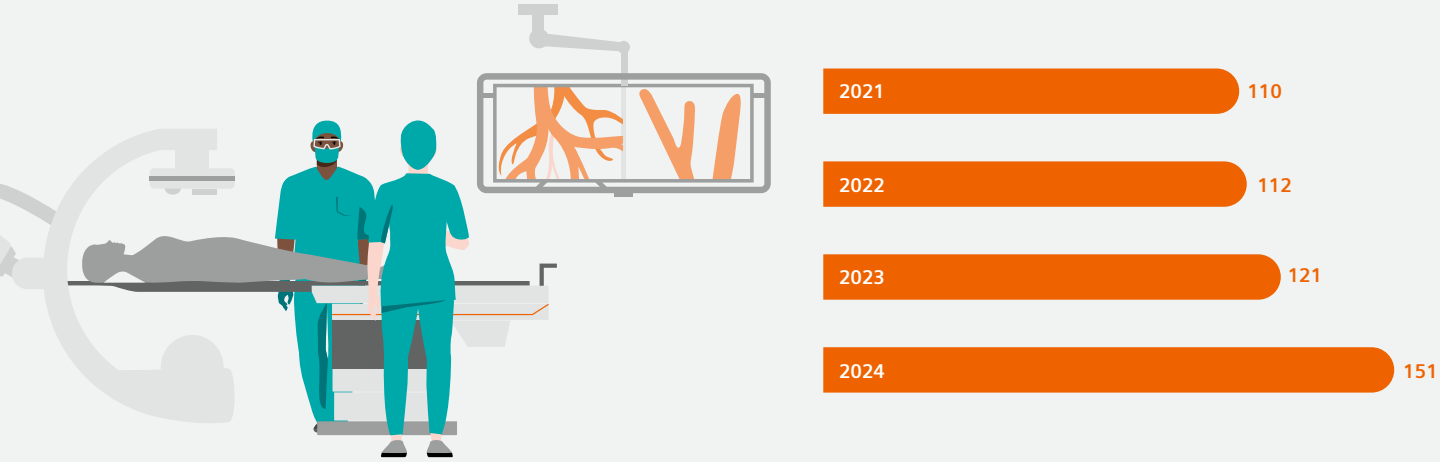

Fig. 5:
Number of complex cardiovascular procedures (like AAA and TAA surgeries) performed per year

5. Conclusions

The utilization data collected over its first four years of room operation shows that the hybrid OR at Yao Tokushukai General Hospital has met operational expectations. The multidisciplinary approach and mixed-use concept have proven to be effective strategies for maximizing hybrid OR utilization. The steady involvement of disciplines beyond cardiovascular surgery from the beginning illustrates hospital-wide interest in sharing the hybrid OR and establishing new treatment methods. At the same time, the efficiency of the OR's use increased significantly during its first four years of operation. Shorter turnaround and case preparation times enabled the treatment of a growing number of cases. A closer look at cardiovascular cases also showed that an increasing number of complex procedures were performed each year. These results indicate that the hybrid OR has indeed expanded the hospital's advanced treatment capabilities.

All of these factors are contributing to increased revenue from the hybrid OR and ensuring a fast return on investment.

In conclusion: The experience acquired at Yao Tokushukai General Hospital shows that installing a hybrid OR can be both a medically and economically attractive choice for medium-sized hospitals.

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