DEPLOYMENT AND OPERATION OF A HYBRID OPERATING ROOM IN A PRIVATE HOSPITAL IN SÃO PAULO

Implantação e funcionamento de sala híbrida em hospital privado de São Paulo

Despliegue y funcionamento de sala de operaciones híbrida en un hospital privado de São Paulo

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ABSTRACT: Objective: To report the experience of the deployment of a hybrid operating room and to identify the demands of its operation in a private hospital in São Paulo, Brazil. **Method:** Retrospective study, with experience report. The database of the surgical center was used to collect information, which was recorded in an instrument (sample characterization, information on the operation, and use of the hybrid operating room). **Results:** The hybrid operating room was used for the care of 166 patients in 15 months; most were men (109; 65.7%), aged 71–80 years (42; 25.3%); diagnosed with aortic stenosis (25.9%), in the specialties: cardiology (70.7%) and vascular (16.5%). The most used features were ArtisZeego® arch C, extracorporeal circulation, audiovisual equipment, software, ultrasound, echocardiography, and Da Vinci® Robot. **Conclusion:** The implementation of the hybrid room is an innovative concept, with the integration of medical teams and the use of next-generation features. The team must be constantly learning, as difficulties in the development of professionals and high costs have limited these procedures to a few centers in the world.

Keywords: Minimally invasive surgical procedures. Intraoperative period. Operating rooms. Technology, high-cost.

RESUMO: Objetivo: Relatar a experiência da implantação de sala operatória híbrida e identificar sua demanda de funcionamento em hospital privado de São Paulo. **Método:** Estudo retrospectivo, com relato de experiência. Para coleta foram utilizadas informações do banco de dados do centro cirúrgico, registradas em instrumento (caracterização da amostra, informações sobre a cirurgia e utilização da sala híbrida). **Resultados:** 166 pacientes foram atendidos em 15 meses; a maioria do sexo masculino (109; 65,7%), faixa etária de 71 a 80 anos (42; 25,3%), com diagnóstico de estenose aórtica (25,9%), nas especialidades cardiologia (70,7%) e vascular (16,5%). Os recursos mais utilizados foram: ArtisZeego®, arco C, circulação extracorpórea, equipamentos audiovisuais, softwares, ultrassonografia, ecocardiograma e Robô Da Vinci®. **Conclusão:** A implantação da sala híbrida é um conceito inovador, com integração de equipes e utilização de recursos de nova geração. A equipe deve estar em constante aprendizado, pois dificuldades na formação dos profissionais e alto custo têm limitado esses procedimentos a poucos centros do mundo.

Palavras-chave: Procedimentos cirúrgicos minimamente invasivos. Período intraoperatório. Salas cirúrgicas. Tecnologia de alto custo.

RESUMEN: Objetivo: Reportar la experiencia de la implementación del quirófano híbrido e identificar la demanda del funcionamiento en un hospital privado en São Paulo, Brasil. **Método:** Estudio retrospectivo, con relato de experiencia. Para la recolección de datos, se utilizó las informaciones de la base de datos del quirófano, registradas en instrumento (caracterización de la muestra, información sobre la cirugía y uso del quirófano híbrido). **Resultados:** 166 pacientes fueron vistos en 15 meses; la mayoría fuera hombres (109; 65,7%), con edades entre 71 y 80 años (42; 25,3%), diagnóstico de estenosis aórtica (25,9%), en cardiología (70,7%) y vascular (16,5%). Los recursos más utilizados fueron: ArtisZeego®, arco C, circulación extracorpórea, equipos audiovisuales, *software*, ultrasonografía, ecocardiografía y Robot Da Vinci®. **Conclusión:** La implementación del quirófano híbrido es un concepto innovador, con integración de equipos y uso de los recursos de próxima generación. El equipo debe estar en constante aprendizaje, pues dificultades en la formación de los profesionales y altos costos han limitado estos procedimientos a unos pocos centros en el mundo.

Palabras clave: Procedimientos quirúrgicos mínimamente invasivos. Periodo intraoperatorio. Quirófanos. Tecnología de alto costo.

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INTRODUCTION

Technology is in constant evolution, and this is reflected in many different sectors, including health. The increasing number of patients with various diseases requires knowledge and innovative techniques, as well as a multidisciplinary team, in the search for a favorable clinical outcome for them[1,2].

Hospitals are increasingly standing out for their technological ability to deploy new concepts, promoting the patient safety, and a recovery free of complications, which may be fatal[3].

One of the examples of the application of global trend technology is the development and creation of a new concept: a hybrid operating room (OR). It consists of the junction of a conventional OR and a hemodynamics room, with physical structure, equipment, materials, and accessories that contribute to less invasive surgery and offer the possibility of surgical and percutaneous correction in the same procedure.

The hybrid OR is equipped with a C-arm device, attached to a robotic arm, which performs broad movements, with three-dimensional reconstructions of the images in real time, providing detailed visualization of anatomy, image fusion, resources for implementation of the aortic valve, conduction of X-ray, and tomography images simulation, contrast ejector pump, radiolucent operating table with flexibility for accurate and comfortable movements in sync with the angiography device, multiple monitors, and lighting with LED surgical lights (Figures 1 and 2). It is important to note that the rooms can be equipped with cameras and image transmission systems, for educational purposes or telemedicine[4-7].

The treatment can be performed in various specialties, focusing mainly on endovascular procedures. The technique has the advantage of reducing the complications inherent to shorter recovery time, pain and infection. However, monitoring of treated patients and the experience gained by the teams, as well as technological developments, will provide the best treatment, individualizing the care provided[5].

Professionals working in the hybrid OR require specific training on the sophisticated equipment, which require skill in handling. The teams necessary are the nursing team, surgeons, anesthesiologists, scrub nurses, perfusionists, cardiologists, echo cardiographers, biomedical or clinical technologists, and engineers, where appropriate[1,4].

The new concept is already a reality in several centers in the world and in some excellence health care centers in Brazil. The structure demands project, planning and high investment, and requires an adequate physical space to provide advanced technology[4,5,8].

In relation to the patient, the benefits of using a hybrid OR include a simultaneous surgical approach with the performance of diagnostic and interventional procedures with the same anesthesia; less surgical trauma; lower rate of blood transfusion when compared to conventional surgery; increased security; and minimally invasive incisions, thus promoting a faster recovery and better aesthetics[4,5].

Given the current scenario, the present study reports the deployment and operation of a hybrid OR, which meets the

Source: Personal archive of the authors, with permission for publication by the institution.

Figure 1. Hybrid operating room of Hospital Israelita Albert Einstein (focus on physical space).

Source: Personal archive of the authors, with permission for publication by the institution.

Figure 2. Hybrid operating room of Hospital Israelita Albert Einstein (focus on equipment).

demands with advanced technology, aiming at safety and the immediate surgical treatment of patients.

OBJECTIVE

To report the experience of deployment and identify the demands of the operation of the hybrid OR of a private hospital in São Paulo.

METHOD

This is an experience report, combined with documentary research. The survey was conducted in a large general hospital of the private network, located in the southern area of São Paulo. The institution has two surgical centers (SC), one with 14 ORs and another with 21 (19 active), in which 3,000 procedures per month are carried out on an average. The hybrid room is located in the SC with 19 ORs, with 180 m², opened on September 24, 2013 (Figures 1 e 2).

The study sample was composed of information contained in the database of the SC, relating to 166 patients admitted for surgical procedures in the hybrid room, with 2 who did not undergo the proposed surgery, amounting to 164 patients operated in the hybrid OR in the period from September 24, 2013 to December 31, 2014. To gather the information in the SC database, we used an instrument, developed by the authors specifically for this research, which contains 16 items, divided into 3 parts: characterization of the sample (gender, age, diagnosis, comorbidities), information about the surgery (date, intervention proposed and carried out, puncture, use of contrast by ejector pump, removal of the introducer, hemostatic dressing or suture of the puncture, need for blood transfusion, surgery time, need for specific care in the immediate postoperative period), and use of the hybrid room (time and resources).

Data collection was carried out between March and June 2015, after approval of the research project by the Research Ethics Committee of the institution, via Platforma Brazil (CAAE – 39502814.7.0000.0071), and authorization by the manager of the two SCs. The results were analyzed quantitatively using statistical resources appropriate to the information collected, and were presented in absolute numbers and percentages.

RESULTS

In the period analyzed, 166 patients used the hybrid room, and two of them did undergo the proposed procedure because 1 had died after a cardiac arrest (before the surgery) and another had complications (acute pulmonary edema and arrhythmia), and the procedure was cancelled.

Of the 166 initial patients, 109 (65.7%) were male and 113 were elderly aged over 60 years (67.9%), predominantly in the age group of 71–80 years (42; 25.3%).

Regarding the diagnosis of the patients admitted to the hybrid OR, the higher incidence was of patients with aortic stenosis (43; 25.9%), followed by 35 with abdominal aortic aneurysm (21.1%), 19 with arterial obstruction (11.4%), and 15 with mitral insufficiency (9.0%). Other diseases occurred in less than 10 patients.

Regarding the presented comorbidities, systemic arterial hypertension stood out, present in 55 subjects of the sample (33.1%), followed by 23 patients with valvular heart diseases (13.9%) and 21 with diabetes mellitus (12.7%).

It is worth noting that, at this stage, the 166 patients enrolled in the 15-month period are being considered, since all were admitted to the hybrid room, though two of them did not undergo the surgery.

For periods in which the hybrid room was used the most, the months of March and April 2014 were the most prevalent, with 18 surgeries (11.0%) and 17 surgeries (10.4%), respectively, followed by the months of August, September, October, and December 2014 (8.0% each).

Regarding the surgery planned and conducted in the hybrid OR, according to the SC database, it was found that in all cases, the procedure performed was the same that was programmed. In this section, we consider the total of 164 patients who actually underwent surgery in the hybrid OR.

The cardiology specialty was the most frequent among the hybrid room procedures, with 116 surgeries (70.7%), followed by vascular (27 surgeries; 16.5%); gynecological and gastrointestinal tract (5 procedures each; 3.0%); pulmonary (4 surgeries; 2.4%); anesthesia (3 procedures; 1.8%); 2 transplants (1.3%); and 2 orthopedic procedures (1.2%). In cardiology, the most performed surgeries were endovascular aneurysm repair (21 procedures, 18.1%), stent implantation and aortic bioprosthesis (20; 17.2%), valve replacement (20; 17.2%), aortic aneurysm repair (19; 16.4%), and percutaneous valve implant (13; 11.2%). In vascular, the procedures that stood out were angioplasties of the

lower limbs (16; 59.3%). The other procedures occurred in fewer than 10 patients in each of the specialties.

Regarding the use of materials and equipment, the following results were obtained: the inguinal puncture was the most used by surgeons, with 117 (71.3%) procedures, among the 164 patients operated; the contrast ejector pump was used in a few cases (3 patients; 1.8%). By promoting greater pressure in the vessels, many surgeons choose to inject the contrast without using the pump, that is, it was up to the team to decide which was the best technique according to the particular patient.

On the removal of the introducer, it was observed that in 45 patients (27.4%), the introducer was removed within the range of approximately 10–15 minutes before or after the surgery; then they performed a pressure dressing and initiated the postoperative care.

The hemostatic dressing or sutures were performed in 49 patients (29.8%) who underwent surgery in the hybrid room, using Perclose® in most procedures.

There was the need for blood transfusion in a small percentage of patients (9; 5.4%), who received blood components in the OR. Of these 9 patients, 3 were submitted to ruptured abdominal aortic aneurysm repair procedure, in which the interaction of the team and the immediate conduct are extremely important for good results, since the incidence of death is very high.

The average duration of surgeries performed in the hybrid room were calculated, according to information obtained from the database. The mean duration of surgery was 3 hours and 21 minutes. It is necessary to clarify that of the 166 surgeries, one was canceled before the start of the procedure; therefore, the average length corresponds to the total of 165 surgeries.

The need for specific care in the immediate postoperative period occurs when surgical approach was arterial or venous, using a form that tracks the evolution of the patient every 30 minutes in the first two hours, which included the presence of bleeding and hematoma (present or absent), perfusion, and pulse (normal or reduced).

On the resources available in the hybrid OR, most procedures used Artis Zeego®, the C-arm, attached to a robot arm; X-ray with CT scanner image; extracorporeal circulation; audiovisual equipment; software with three-dimensional images; ultrasound device; echocardiography, and the Da Vinci® Robot. Thus, the resources available in the room were used by the teams, which facilitates and contributes to the satisfactory outcome of the procedure.

The average length of stay of patients in the hybrid room was 5 hours and 7 minutes, and the average was calculated for the 166 patients who remained in the OR during the study period. Two patients did not complete the procedure, but one remained in the room until the complication before the proposed procedure, and the other remained until presenting cardiorespiratory arrest and having their death confirmed by the medical team.

DISCUSSION

In this study, it was found that the deployment of the hybrid OR became allied with the success of surgical, hemodynamic, and high-complexity procedures. In the period of 15 months, 166 patients were treated in this SC, and 2 did not undergo the proposed procedure, as described in the results.

The patients were predominantly male: elderly, aged from 61 to 80 years, diagnosed with aortic stenosis. Studies report that aortic stenosis is the most common heart valve disease, with insidious origin, rapid progression, and high mortality rate if untreated, and usually occurs in patients over 75 years. The procedure of choice for the treatment of stenosis is aortic valve replacement. Ideally, the procedures are to be performed in hybrid rooms, or in a space suitable for this purpose, as the room provides great ergonomics, high technology, ease of access to the detailed anatomy, monitoring and rapid intervention in case of need for cardiopulmonary bypass[9].

Considering the patients with contraindications to conventional surgery due to high mortality rates, the use of the hybrid OR is highly indicated, as the technology infrastructure provides the team with interventions of greater precision, less trauma, better results, and fast recovery, which are considered benefits of this SC[9,10].

Regarding the space of the room, there is the possibility of operation of several teams in the same surgery, allowing the sum of their knowledge according to their expertise and experience, which contributes to a planned assistance. Its structure covers approximately 13 people in the same environment, remembering that the space facilitates the mobility of teams and promotes safety in an emergency, without the need of changing rooms, which would cause inconvenience and risk of complications[11].

Currently, the hybrid OR is only available in some institutions in Brazil, especially in big cities like São

Paulo. The Hospital do Coração (HCor) offers two hybrid rooms, one exclusively for cardiology and another for procedures in the neurological, orthopedic, and other specialties. The Hospital Israelita Albert Einstein (HIAE) has a room called the technology park, as it is equipped with cutting-edge technological infrastructure. In Belo Horizonte, Minas Gerais, the Mater Dei Hospital also has a hybrid room. The hybrid OR is gaining popularity, due to its ample and versatile environment, distributing its equipment and accessories in an organized form[11].

In this study, the procedures performed in the cardiology specialty, followed by vascular, were the most prominent. The OR was also used by doctors in the gynecology, gastrointestinal tract, lung staff, transplantation, anesthesia, and orthopedics specialties.

The most common procedures for interventional cardiology in the hybrid OR were endovascular aneurysm, stent implantation and aortic bioprosthetic, valve replacement (aortic and mitral), aortic aneurysm repair, and percutaneous valve implant. It also covers numerous procedures in cardiology[11].

Cardiac surgery has gained tremendous visibility compared to previous years. The evolution of technology with innovative techniques is promising in the treatment using minimally invasive techniques, such as the aid of a robotic system[10].

The use of robotics is through a console, guided by high-definition images, from which the surgeon controls the movements of a robot equipped with four flexible and articulated arms. The arms are properly fitted by a nursing professional who operates in the OR, usually a trained nurse or nursing technician. One arm of the robot has a camera that captures three-dimensional images, and the others manipulate special surgical instruments. The procedure is performed through small holes, similar to the conventional laparoscopy, but with an extremely detailed view of the internal structures and with perfection never seen before in this type of surgical procedure. These technological robots find their place in the hybrid OR, as most conventional rooms do not include such equipment[9-11]. The institution under study here has two Da Vinci® System robots.

Studies[9-11] have shown the need for qualified and trained professionals to work in hybrid ORs, as the great difficulty in the learning curve and the high costs have limited these procedures to a few centers in the world. But professional interest in the access to these rooms has raised significant issues regarding the standardization of materials and the number of people needed. The nurses who work in the hybrid OR must be constantly learning, because the room has differentiated technologies and features that require great attention and responsibility[9-11].

Due to the high cost, the need of knowledge for handling equipment, care, and diligence are of paramount importance to the proper functioning of the room. Professionals should keep the organization accessories, equipment, and parts properly identified and sanitized in order to facilitate the work in highly complex procedures.

The technological resources available in this room are being increasingly exploited by the medical teams. In this study, there was a significant incidence of use of equipment and accessories, and, in most procedures, the following were used: Artis Zeego®, C-arm, attached to a robot arm with almost 360-degree movements, as well as the X-ray device that simulates a CT scanner with accurate image, radiolucent operating table, with full flexibility for accurate and comfortable movements; cutting edge extracorporeal circulation; audiovisual equipment, with monitors that distribute the images according to the need of the team, software resources with three-dimensional reconstruction of images used in real time, ultrasound device, echocardiography, and Da Vinci® Robot[10,11].

The deployment of the hybrid room is an innovative concept, which promotes integration of the entire team, plus the latest resources to help guide the best approach for treatment. It is being increasingly used and sought, as it is able to support various diseases and peculiarities, integrating two surgical times (diagnostic and therapeutic), in which the precision and the involvement of all professionals provide security to the surgery and allow the team to rapidly assess the clinical outcome.

Thus, we must consider that the involvement, empowerment, and training of all professionals working in the hybrid room are indispensable to a successful treatment[9-11].

CONCLUSION

The experience of the deployment of a hybrid OS in a private institution in São Paulo has proven useful and effective, and is being used by teams of different specialties working together, sharing experiences in the search for better treatments with satisfactory results. Advanced technology provides the involvement of professionals who conduct surgical, hemodynamic, and high-complexity procedures.

This study found that in the period between September 24, 2013 and December 31, 2014 (15 months), the operating demand for use of the hybrid OR was of 166 patients. The patients were usually male, elderly, and diagnosed with aortic stenosis.

The largest number of surgeries was conducted in March and April 2014, in the cardiology and vascular specialties. In cardiology, the procedures for aortic aneurysms repairs (endovascular and conventional), aortic prosthesis implantation, and valve replacement (percutaneous and conventional) were the most prominent; and, in vascular, it was angioplasty of the lower limbs. Among the features most used in the hybrid room are ArtisZeego®, C-arm, extracorporeal circulation, audiovisual equipment, software with three-dimensional images, ultrasound, echocardiography and Da Vinci® Robot.

Thus, the hybrid OR is already present in some institutions in Brazil, and the performance of the team should be constantly evolving in learning, because the difficulties in forming and training professionals, as well as the high cost, have limited these procedures to a few centers in the world.

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