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(Research Article)

Mindray Anesthesia Machine Repair Type Wato Ex-65 at Columbia Asia Special Surgery Hospital Semarang

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Abstract. Anesthesia machines are very important medical equipment in modern medicine, especially in medical procedures and intensive care. This device is designed to provide and control the administration of anesthetic drugs and medical gases to patients safely and measurably. Damage to the oxygen regulator block of the anesthesia machine shows a discrepancy with the indicator reading. This problem is very critical because it can cause the administration of inappropriate oxygen concentrations to patients during anesthesia procedures. This activity aims to support health services at the Columbia Asia Semarang Hospital which has a damaged anesthesia machine and wants to be repaired, namely the Mindray Type Wato EX-65 anesthesia machine. Damage to the device is known by disassembling the device, by visual observation, checking for hose leaks, and measuring at certain points in the device circuit. Based on the analysis carried out, the damage is in the anesthesia machine regulator block. After repairs and functional tests using VT 305 to check the air flow, it was declared suitable for use..

Keywords : Anesthesia machine, Air flow, VT 305.

1. Introduction

Electromedical services are an inseparable part of health efforts and are oriented towards the safety, benefits, accuracy and effectiveness of electromedical equipment for patients, operators, managers, the community and the environment. The scope of electromedical services includes activities such as analyzing needs for client proposals, making technical considerations in the purchasing process, installation, monitoring functions, testing and/or calibration, maintenance, repairs, technical studies in the removal, and quality control of electromedical equipment (Kusumaningtyas et al., 2023) . Maintenance of medical devices is carried out through two main approaches, namely preventive maintenance and corrective maintenance. Preventive maintenance aims to prevent damage by routinely checking and replacing certain components before a disruption occurs, while corrective maintenance is carried out when the device is damaged or malfunctioning.

Anesthesia machines are medical devices that play an important role in supporting various medical procedures in hospitals, especially in surgical procedures. Anesthesia machines are medical support tools that greatly assist medical personnel during the surgical procedure. Anesthesia machines provide anesthetic agents and gases needed by patients during the anesthesia process (Yudihart et al., 2023) , (Inhalasi et al., 2023) . Malfunctions in anesthesia machines during surgery are medical emergencies that require immediate and coordinated treatment from the entire surgical team. When this happens, the top priority is to ensure patient safety by immediately switching to manual ventilation using a breathing bag to maintain adequate oxygenation (Suharti et al., 2016) , (Putra et al., 2022) . Of the 66 cases of anesthesia machine failure, 33.3% were found to be due to air leaks, and 13.6% failed the self-test due to problems (Li et al., 2023) . In another study, PEEP/Pmax valve failure was identified in 7 of 22 Fabius machines due to unexpected deposits. Although component replacement was initially effective, one machine had recurrent problems, prompting a full inspection by the manufacturer (Ikeda et al., 2021) .

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At the Columbia Asia Special Surgery Hospital in Semarang, an anesthesia machine was found to be not functioning optimally, namely the mismatch in the oxygen indicator reading. When tested, the oxygen indicator on the machine could not return to zero and only showed 0.6, even though the gas flow was stopped. This condition indicates damage to the gas rate reading system, which has the potential to endanger patient safety if not treated immediately. Therefore, evaluation, repair, and preventive measures are needed to ensure that the device can function normally again. The repair process for the Mindray WATO EX-65 anesthesia machine at the Columbia Asia Special Surgery Hospital in Semarang was carried out by identifying the type of damage that occurred, as well as compiling recommendations for effective maintenance strategies. It is hoped that the results of this study can contribute to supporting the sustainability of the device's function, improving the quality of anesthesia services, and strengthening the medical device management system in hospitals..

2. Literature Review

Understanding Anesthesia Machines

Anesthesia machines are medical support tools that greatly assist medical personnel during the surgical procedure. Anesthesia machines provide anesthetic agents and gases needed by patients during the anesthesia process (RAMADHAN, 2018) , (Widdin, 2018) . Modern anesthesia machines are designed to provide an accurate and continuous supply of gases such as oxygen and nitrous oxide mixed with anesthetic agent vapors such as isoflurane and sevoflurane, which are delivered at a flow and pressure that is safe for the patient. There is also a flow sensor on the anesthesia machine that is used to read tidal volume. This sensor is important in monitoring the patient's inspiratory and expiratory flow (Gulo & Rahmah, 2021) , (Ummah, 2019) . Modern anesthesia machines are equipped with ventilators, suction units, and other supporting equipment. The main function of the anesthesia machine (gas machine) is to flow safe anesthetic gas or gas mixture into the anesthetic circuit which is then inhaled by the patient and removes the remaining gas mixture from the patient (Gulo & Rahmah, 2021) , (Ridconi, 2017) .

Working Principle of Anesthesia Machine

The working principle of anesthesia machine involves several main components as shown in Figure 1, namely gas source, vaporizer, and breathing circuit. The gas source provides oxygen (O_2), nitrous oxide (N_2O), and air, the flow of which is regulated by a pressure regulator and flowmeter. These gases are then mixed with the anesthetic agent in the vaporizer, which changes it into a gaseous form with the right concentration for the patient's needs (Suharti et al., 2016) .

This anesthetic gas mixture is then channeled to the patient through the breathing circuit, where the patient inhales the gas. During this process, the anesthetic gas enters the lungs, penetrates the alveoli, and reaches the bloodstream to reduce consciousness. After the patient exhales, the remaining gas is removed from the circuit to prevent re-inhalation of carbon dioxide (CO_2) (Prof. Dr. Abdurachman, dr., M.Kes., 2023).

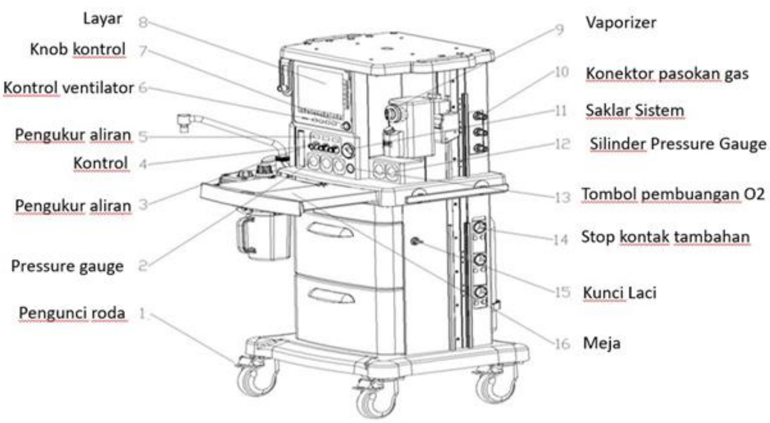

Figure 1. Anesthesia Machine Parts

Use of Anesthesia Machines

The use of anesthesia machines requires special attention and skills to ensure patient safety during surgical procedures. Before use, it is important to check all pipe connections of the anesthesia machine to ensure that they are properly connected, including the air intake pipe to the cylinder or central air supply port.

The stages of using an anesthesia machine are as follows:

1. Open the oxygen cylinder and adjust the air supply pressure to about 0.4 MPa.
2. Turn on the power supply to the anesthesia machine and check for possible air leaks.
3. Set parameters such as flow, tidal volume, respiratory rate, and respiratory ratio according to the patient's condition.
4. Perform a ventilator test run to ensure all functions are normal before connecting to a patient.
5. Connect the tubing to the patient and turn on the ventilator and evaporator switches to administer anesthesia.
6. Monitor the measurement data on the anesthesia monitor and make adjustments if necessary.
7. After the procedure is complete, turn off the ventilator and vaporizer, and replace the patient's sterilized breathing circuit if it will be used for subsequent operations.

Anesthesia Machine Maintenance

Maintenance of anesthesia machines can be carried out periodically like other electromedical devices, namely daily, weekly, monthly, semi-annual and annual maintenance (Kusumaningtyas et al., 2023) . Table 1. is the periodic maintenance required for anesthesia machine equipment.

Table 1. Periodic Maintenance of Anesthesia Machines

Period	Maintenance Activities
Daily	It is important to clean the anesthesia machine and all equipment that comes into contact with the patient with soap and disinfectant after each use. Be sure to check connections and components, including the anesthesia gas cylinder, oxygen reservoir, and vaporizer, for blockages or leaks.
Weekly	Check or replace the oxygen sensor and flow sensor if they cannot be calibrated properly.
Monthly	Wash the air conditioning filter to maintain good air circulation and prevent dirt buildup that can affect engine performance.
Semi-Annual	A thorough inspection by a qualified technician to ensure that all components are functioning properly and that there is no damage that could affect patient safety.
Annual	Calibration of the anesthesia machine by a professional technician is required annually to ensure that all measurements and functions of the device remain accurate.

3. Method

This study uses a descriptive analytical approach with a case study method on the repair of Mindray Type Wato Ex-65 anesthesia machines at the Columbia Asia Special Surgery Hospital in Semarang. Data collection was carried out through several stages including observation of the physical condition and function of the machine, document examination by reviewing the service manual and machine maintenance records, measuring electrical quantities, and making repairs and testing the function of the device. Data analysis was carried out by comparing the measurement results with the standards set by the manufacturer and evaluating the performance of the device after repair..

4. Results and Discussion

Repair Process

The repair process begins with the dismantling of the anesthesia machine to replace and repair the dismantling of the tool is done on the back cover . Furthermore, the hoses that connect to the regulator to supply the gas supply are removed because the hoses interfere with the repair process, which is shown in Figure 2 below.

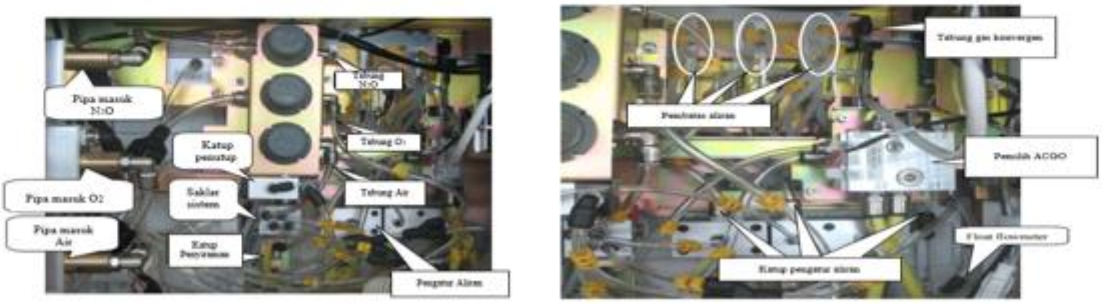

Figure 2. The hose on the anesthesia machine is visible.

Then the dismantling of the anesthesia machine and repair of the regulator block is carried out by replacing several seals in order to prevent leakage, which is shown in Figure 3 below.

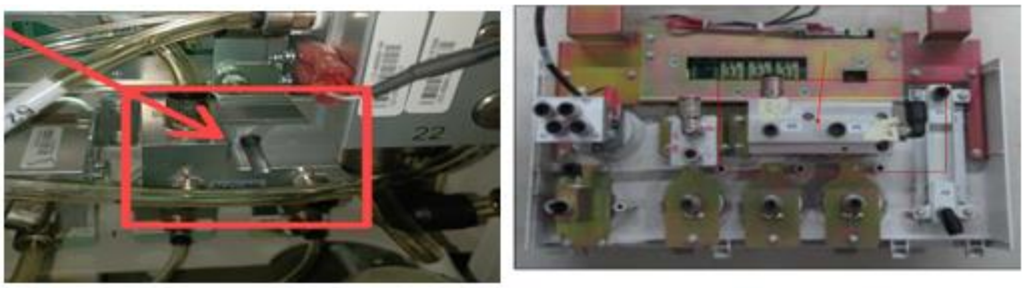

Figure 3. Damaged regulator block

The next process is to reassemble the anesthesia machine as before, such as installing the hoses that have been removed in their place and returning the back cover of the anesthesia machine. Function testing is done by turning on the anesthesia machine and seeing the oxygen indicator which was previously at 0.6 returns to normal and is at point 0.0 as seen in Figure 4.

Figure 4. Appearance of the tool during function testing.

Functional Test Process

After the repair is complete and the anesthesia machine is functioning, the next step is to perform a function test. According to regulations, the repaired device must be immediately calibrated by the calibration vendor. The first measurement is the measurement of oxygen air flow in the range of 1-5 lpm which is repeated 6 times with a tolerance of ±10%. The results of the function test are listed in Table 2 and Table 3.

Table 2. Oxygen flow values

Oxygen Air Flow (lpm)	Standard Reading lpm						Tolerance
	1	2	3	4	5	6	
1	1.2	1.2	1.2	1.2	1.2	1.2	±10%
2	2.3	2.2	2.2	2.2	2.2	2.1	
3	3.4	3.3	3.3	3.3	3.2	3.2	
4	4.4	4.4	4.3	4.3	4.3	4.4	
5	5.5	5.5	5.5	5.4	5.4	5.4	

Table 3. Nitrogen flow values

Air Flow (lpm)		Standard Reading lpm						Tolerance
O_2	N2O	1	2	3	4	5	6	
5	1	6.5	6.4	6.3	6.5	6.6	6.2	±20%
5	2	7.6	7.6	7.2	7.2	7.6	7.6	
5	3	7.9	9.5	8.2	8.3	8.8	9.9	
5	4	9.1	10.6	9.2	9.7	10.7	11	
5	5	10.6	11.8	10.4	10.8	11.9	12.2	

Based on the measurement results, all values are within the tolerance range. set, indicating that the anesthesia machine is functioning properly after repair.

5. Conclusion and Suggestion

Conclusion

Based on the results of the analysis and improvements, the following conclusions can be drawn: Damage analysis is carried out through the process of checking the initial condition of the device, physical, internal, and external conditions of the Mindray Type WATO EX-65 anesthesia machine and checking the flow of oxygen, nitrogen, and air. Damage was found in the oxygen regulator block, which is indicated by the indicator showing the number 0.6 and the screen also showing the same number. This indicates that the problem is in the regulator block, because if only the indicator is problematic, the screen should show the number 0 when there is no gas flow. Repairs to the Mindray Type WATO EX-65 anesthesia machine were carried out by replacing the regulator block and several seals to prevent leakage. Functional test on Mindray Type WATO EX-65 anesthesia machine showed that the device has been functioning properly after repair. The oxygen indicator returned to position 0 and the calibration results using VT 305 to test the oxygen and nitrogen airflow showed values that were within the permitted tolerance limits. Thus, it can be concluded that the anesthesia machine is suitable for reuse.

Suggestion

Replacement components must be in accordance with the specifications recommended by the manufacturer so that the tool's performance remains optimal when used. It is necessary to carry out preventive maintenance periodically to detect potential damage early and prevent equipment failure during use. Documentation of repair and maintenance history needs to be optimized to facilitate analysis of damage patterns and necessary preventive actions in the future.Further research can be focused on a comprehensive analysis of the factors influencing block regulator failure in anesthesia machines..

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