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Heart-Lung Machine: How Critical Care Nurses Detect Pumphead?

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Abstract: **A medical equipment that provides Cardiopulmonary bypass, (temporary mechanical circulatory support) to the stationary heart and lungs. Heart and Lungs are made "functionless temporarily", in order to perform surgeries as coronary artery bypass grafting. Its benefit is allow doctor to operate in a blood-free area, should contribute to less surgical error. Its major complications or disadvantage is Pumphead" syndrome-some effect can include defects to attention concentration, short term memory loss and fine motor function. Nurses carry the responsibility about the early recognition and/or detection of Pumphead syndrome among postoperative cardiac patients, nurses—who spend more time at the patients' bedside—play a crucial role and knowing these risk factors can reduce the incidence of it. Since nurses are in close contact with the patients, they would able to observe and report neurological assessment as level of consciousness, they easily recognized decreased level of consciousness, additional the behavioral changes due to delirium fluctuations. Critical care nurses often manifested delirium in three modes: hyperactive, hypoactive, and mixed. Hyperactive delirium, which is easily recognized, is accompanied by symptoms such as irritability in behavior, hallucination and delusion. On the other hand, hypoactive delirium is presented by withdrawal symptoms, decreased attention, and decreased motor activity. They take their attention regarding symptoms of hallucination and delusions are less common and require more nursing care. In the future, the heart-lung pump will hopefully become portable, allowing for paramedics to aid heart attack patients on the scene, for instance. Also, the device will be further developed to allow for less brain damage after the surgery.**

Keywords: **Heart-Lung Machine, Critical care nursing, Pump head.**

1. INTRODUCTION

The heart–lung machine is a system which takes over the function of the heart and the lungs with sufficient safety to maintain life while the heart is stopped or opened to allow surgery on the coronary arteries or the heart valves, or to allow repair of congenital abnormalities. Heart–lung machine is a technology machine also causes adverse effects on a patient's body and cognitive functions [1].

Heart–lung machine operating on the human heart poses problems which inhibited surgery on the heart until the early 1950s. Manipulation of the heart and opening of its cavities' interferes with its function and its ability to sustain the circulation. Heart–lung machine or. Cardiopulmonary bypass pumps are operated by perfusionists. CPB is a form of extracorporeal circulation. Extracorporeal membrane oxygenation is generally used for longer-term treatment [2].

1.1. Component parts of heart–lung machine (HLM):

It consists of two main functional units: the pump and the oxygenator. Its component parts are: Tubing - The components of the CPB circuit are interconnected by a series of tubes made of silicone rubber or PVC. Pumps (1) Roller pump - The

pump console usually comprises several rotating motor-driven pumps that peristaltically "massage" tubing. - This action gently propels the blood through the tubing. - This is commonly referred to as a roller pump, or peristaltic pump [3].

1.1.1. Table (1) Components of heart-lung machine and its figure [4].

- Cardioplegia
- Cannula
- Blood reservoir
- Heparin Pump
- Roller pumps/Centrifugal pump
- Oxygenators
- Heat Exchanger

1.1.2.Table (2) Functions of Heart- Lung Machine parts [5&6].

The HLM is the basis of ECC and cover two important organ functions :-

1. Pump function of the heart
2. Gas exchange function of the lungs

It must ensure :-

- A sufficient perfusion volume that corresponds to the normal cardiac output of the patient under anesthetic
- An adequate perfusion pressure (50–90 mmHg)
- It must also ensure sufficient oxygenation, elimination of CO_2, and control of the blood temperature

The following components make up the basic equipment of the ECC that is used during modern cardiac surgery:

1. Blood pumps
2. Oxygenator
3. Tubing system with various tubing diameters
4. Blood filters with various functions
5. Cardiotomy reservoir
6. Cannulae and intracardiac suction tubes

1.1.3. Surgical procedures in which cardiopulmonary bypass is used [5&6]:

- Coronary artery bypass surgery
- Cardiac valve repair and/or replacement (aortic valve, mitral valve, tricuspid valve, pulmonic valve)
- Repair of large septal defects (atrial septal defect, ventricular septal defect, atrioventricular septal defect)
- Repair and/or palliation of congenital heart defects (Tetralogy of Fallot, transposition of the great vessels)
- Transplantation (heart transplantation, lung transplantation, heart–lung transplantation)
- Repair of some large aneurysms (aortic aneurysms, cerebral aneurysms)
- Pulmonary thromboendarterectomy.
- Pulmonary thrombectomy.

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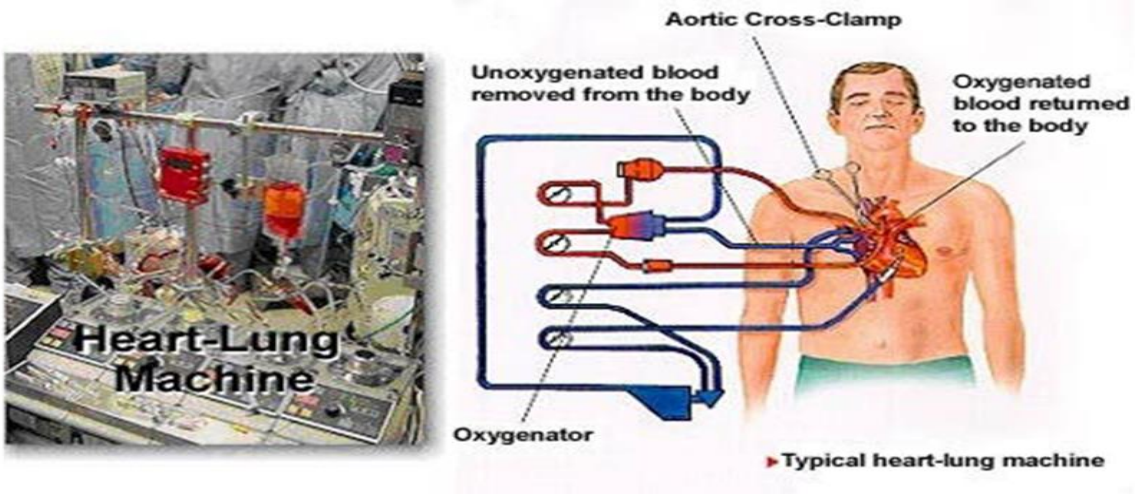
1.1.4. Connections technique between HLM and patient circulation [6&7].

- CPB mechanically circulates and oxygenates blood for the body while bypassing the heart and lungs.
- It uses a heart–lung machine to maintain perfusion to other body organs and tissues while the surgeon works in a bloodless surgical field.
- The surgeon places a cannula in right atrium, vena cava, or femoral vein to withdraw blood from the body.
- The cannula is connected to tubing filled with isotonic crystalloid solution.
- Venous blood that is removed from the body by the cannula is filtered, cooled or warmed, oxygenated, and then returned to the body.
- The cannula used to return oxygenated blood is usually inserted in the ascending aorta, but it may be inserted in the femoral artery.
- The patient is administered heparin to prevent clotting, and protamine sulfate is given after to reverse effects of heparin.
- During the procedure, hypothermia is maintained; body temperature is usually kept at 28ºC to 32ºC (82.4–89.6ºF).

1.1.5. Figure illustrates typical Heart-Lung Machine Connections with patient [7].



1.1.6. Advantages of Cardiopulmonary bypass machine during heart surgery:

Cardiopulmonary bypass machine is commonly used in heart surgery because of the difficulty of operating on the beating heart. Operations requiring the opening of the chambers of the heart require the use of CPB to support the circulation during that period. The machine nourishes the blood cells and allows them to continue cellular respiration even through surgery [7]. CPB can be used for the induction of total body hypothermia, a state in which the body can be maintained for up to 45 minutes without perfusion (blood flow). If blood flow is stopped at normal body temperature, permanent brain damage normally occurs in three to four minutes — death may follow shortly afterward. Similarly, CPB can be used to rewarm individuals suffering from hypothermia [8].

1.1.7. Mechanism of Heart -Lung Machine working:

The heart-lung machine, or perfusion pump, is composed of a chamber that receives all the blood from the body, which is the responsibility of the right atrium of the heart. The machine then pumps the blood through an oxygenator, which is the function of the right ventricle. This oxygenator removes the carbon dioxide and adds oxygen to the blood, which is the typical function of the lungs [7].

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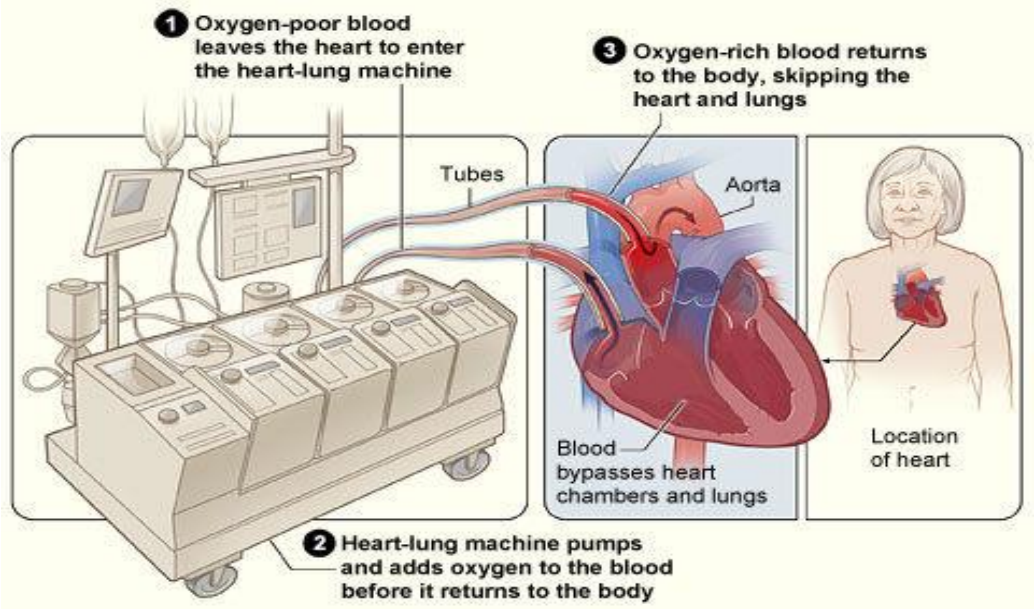
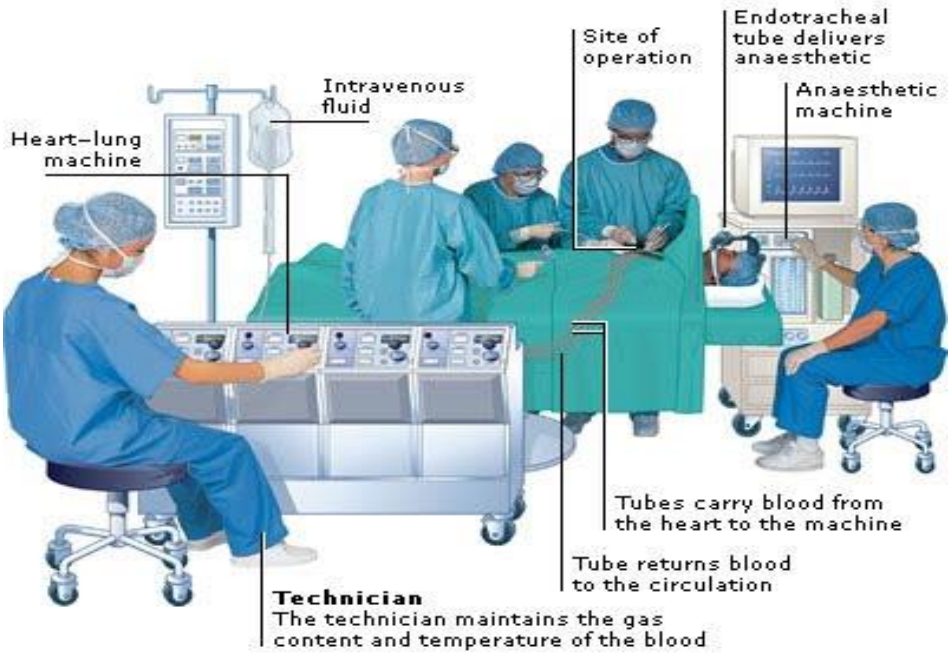
The machine then continues by pumping the oxygenated blood back to the body, which is the function of the left atrium and ventricle. This process is possible by a series of tubes that are connected to the patient by a team of surgeons. The heart-lung machine itself is operated by perfusionists during the surgery. To end an operation, the surgeon gradually lets the patient's heart resume its normal functions [9].

1.1.7.1. Diagram illustrate HLM working [9&10]:



1.1.8. Other machines connected during open heart surgery [11].



1.1.9. Monitoring of patient on heart lung machine:

Continuous scanning of all patient monitors is necessary for proper treatment and troubleshooting [12]. Documentation of patient status is obtained every 15–30 minutes. This information allows the physician and nursing staff to follow trends that will help better manage the patient once treatment is discontinued [13]. At the termination of device support, the perfusionist or ECMO specialist must communicate clearly to the physician all changes in support status [14]. This

allows the entire team to assess changes in patient parameters that are consistent with the patient becoming less dependent on the device, while the patient's heart and lungs meet the metabolic demands of the body. It is the responsibility of the perfusionist to be at the device controls at all times [15, 16&17].

1.1.10. Disadvantage or adverse effect of HLM:

About 20-40% of patients set to undergo CABG surgery already had some degree of cognitive decline before the operation. It was assumed that this was a complication of the heart-lung machine. Cerebral oxygen desaturation predicts cognitive decline and longer hospital stay after cardiac surgery [18].

Pumphead also known as post perfusion syndrome is a constellation of neuro-cognitive impairments attributed to cardiopulmonary bypass (CPB) during cardiac surgery. Symptoms of post-perfusion syndrome are subtle and include defects associated with attention, concentration, short term memory, fine motor function, and speed of mental and motor responses [19].

1.1.11. Incidence and onset of neurocognitive deficit:

Incidence of cognitive impairment varying between 3% and 79% among post-operative cardiac patients. Neurocognitive deficit occurred rapidly after surgery, but the deficits are often transient with no permanent neurological impairment. It may last from a few days to a few weeks after surgery. In rare cases, this disorder may persist for several months [20].

1.1.12. How can diagnose of Pumphead:

Pumphead can be diagnosed by poor attention span, poor memory, poor decision making, inability to concentrate, reduced speed of movement, and a general impairment in the ability to think clearly [21]. More severe symptoms such as overt delirium can also be seen rarely. These symptoms can appear immediately after surgery, and can range greatly in severity from incapacitating to barely noticeable. Cognitive deficits most commonly resolve gradually, over a period of a few weeks or months, but in some cases they can persist for years [22].

1.1.13. Mechanism of Pumphead:

Surgeons have hypothesized that the syndrome is caused by tiny debris and air bubbles (micro-emboli) that enter the brain via cardiopulmonary bypass. Surgeons attempt to diminish time spent on bypass to decrease postoperative deficits; studies have shown increased bypass time is associated with increased incidence and severity of post-perfusion syndrome and mortality [23]. It is unclear how increases in bypass time would result in such increases if pre-existing cardiovascular and cerebrovascular conditions are the principal causative mechanisms of post-perfusion syndrome [24].

Critical care nursing is the field of nursing with a focus on the utmost care of the critically ill or unstable patients following extensive injury, surgery or life threatening diseases [25].

1.1.14. How Critical Care Nursing Detects Pumphead?

Nurses carry the responsibility about the early recognition and/or detection of Pumphead syndrome among postoperative cardiac patients, nurses—who spend more time at the patients' bedside—play a crucial role and knowing these risk factors can reduce the incidence of it [26].

Since nurses are in close contact with the patients, they would able to observe and report neurological assessment as level of consciousness, they easily recognized decreased level of consciousness, additional the behavioral changes due to delirium fluctuations [27].

Critical care nurses often manifested delirium in three modes: hyperactive, hypoactive, and mixed. Hyperactive delirium, which is easily recognized, is accompanied by symptoms such as irritability in behavior, hallucination and delusion. On the other hand, hypoactive delirium is presented by withdrawal symptoms, decreased attention, and decreased motor activity. They take their attention regarding symptoms of hallucination and delusions are less common and require more nursing care [28].

So they identify the responsible physicians to start the following interventions, which need some tests as hematocrit levels of lower than 30% reduced cardiac output, use of balloon pump, use of inotropic medication, intubation more than 24 hours, need for re-surgery, post-surgical dysrhythmias, infusion of more than 4 units of packed red cells, infusion of more

than one unit of fresh frozen plasma, carbon dioxide level of more than 45 mmHg, more than 60 mmHg decrease in the arterial oxygen level, elevated blood sugar, reduced blood sugar, elevated temperature, and increased serum sodium, and urea levels [29&30].

In the future, the heart-lung pump will hopefully become portable, allowing for paramedics to aid heart attack patients on the scene, for instance. Also, the device will be further developed to allow for less brain damage after the surgery.

2. CONCLUSION

Heart–lung machine is a technology machine also causes adverse effects on a patient's body and cognitive functions**.** Pumphead also known as post perfusion syndrome is a constellation of neuro-cognitive impairments attributed to cardiopulmonary bypass (CPB) during cardiac surgery. Nurses carry the responsibility about the early recognition and/or detection of Pumphead syndrome among postoperative cardiac patients, nurses—who spend more time at the patients' bedside—play a crucial role and knowing these risk factors can reduce the incidence of it.

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