Limitations of two common resuscitation bags: a case study to address gaps in knowledge

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Objectives

- Address potential gaps in provider knowledge to improve patient safety
- Demonstrate the ability or limitation of self-inflating bags and flow-inflating bags to provide forward airflow with and without the addition of a positive end expiratory pressure valve
- Describe the non-rebreathing valve on common self-inflating manual resuscitation bags that prevents blow-by oxygenation

Introduction

- A thorough understanding of the strengths and limitations of manual resuscitation devices is critical for the anesthesiologist, as well as other healthcare professions that may be required to use them in medical emergencies.
- Two commonly used manual resuscitation devices are self-inflating bags (SIB), such as the bag-valve-mask (BVM), or a flow-inflating/anesthesia bag (FIB) [1].
- A cornerstone of successful resuscitation is the avoidance of hypoxia which can be achieved by providing supplemental oxygen to patients with these devices.
- SIBs are an excellent choice for most scenarios due to their simplicity and wide availability.
- FIBs are often used by anesthesiologists, especially in pediatrics, due to the improved tactile sensation and better control of tidal volumes but are more complicated to use [2].
- A potential knowledge gap is the inability of the SIB to provide blow-by oxygenation to a spontaneously breathing patient due to the expiratory valve.

Description

- SIB and FIB systems were assembled in standard fashion, and each connected to a standard medical oxygen cylinder. The patient connection port of each system, which generally connects to a face mask, was submerged in a large, water-filled container.
- Oxygen was turned on and flow rate was increased at intervals from 6 to 10 to 15 to 25 L/min. Observation of whether oxygen was flowing through the system was made by determining if air bubbles were visible through the water.
- The PEEP valve was attached to each system and PEEP of 10 and 15 cm H_2O was added in addition to the oxygen. Observation of presence of absence of oxygen flow was made as described above.
- The trial with the SIB system did not yield air bubbles from the connection port with oxygen flow rates of 6, 10, 15, or 25 L/min or with the addition of PEEP at 10 and 15 cm H_2O (Figure 1).
- The trial with the FIB system did yield air bubbles from the connection port with oxygen flow rates of 6, 10, 15 and 25 L/min and continued to do so with the addition of PEEP at 10 and 15 cm H_2O (Figure 2).

Images

Figure 1. Self inflating bag with patient connection port submerged in water while oxygen is connected at a flow rate of 15L/min with PEEP valve. Lack of bubbles in the water demonstrates lack of forward flow through the system.

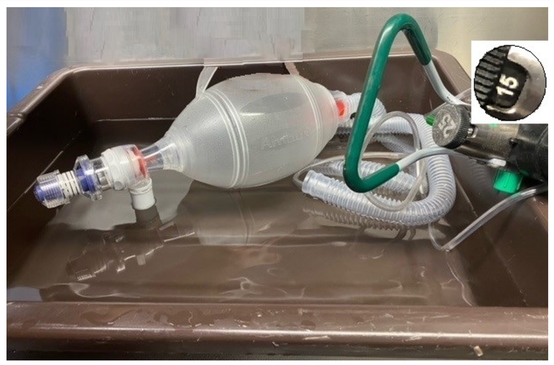

Figure 2. Flow inflating bag with patient connection port submerged in water while oxygen is connected at a flow rate of 6L/min. Bubbles in the water demonstrate presence of forward flow through the system.

Discussion

- SIBs, such as BVMs, are frequently used as an oxygen source in resuscitation and do not provide adequate forward flow for blow-by oxygenation in a spontaneously breathing patient.
- This is due to the non-rebreathing valve located next to the patient connection port. This valve can only be opened by squeezing the SIB or if sufficient negative pressure is generated from the patient.
- This experiment demonstrates forward flow of oxygen through the FIB system and lack of forward flow through the SIB system. There is potential for hypoxia and rebreathing of carbon dioxide caused by the lack of forward flow in the SIB system.
- Ambu is the manufacturer of a popular model of SIB/BVM. Their instruction manual does not specifically describe the valve or lack of forward flow through the system without active squeezing of the bag.
- The “Warning Section” states, “Do not use the Ambu Mark IV when delivery of free-flow oxygen is needed due to possible insufficient administration of oxygen, which can lead to hypoxia”. However, the “Product Use” section states, "The gas flow is similar when the patient is breathing spontaneously through the device”[3].
- Medical personnel may confuse this information to mean the SIB is appropriate for blow-by oxygenation.
- Literature review through the PubMed database and review of instruction manuals for different models of SIBs failed to yield specific descriptions of the phenomenon described in this case study.

Conclusion

- Ventilation and oxygenation are critical components of resuscitation. Lack of proper blow-by oxygenation may lead to hypoxia, which is potentially life-threatening.
- SIBs are an excellent tool when used appropriately. Without squeezing the SIB, blow-by oxygenation is not provided to the patient. This is dangerous and could result in patient harm or death.
- Literature describing proper use of manual ventilation is scarce. Many providers may be unaware of the limitations of these devices. It is important to address these gaps in provider knowledge to ensure patient safety.

References

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