Chapter

29

Self-inflating Bag: Manual Resuscitator

The self-inflating bag, as its name implies, inflates automatically without a compressed gas source. It remains inflated at all times, ready for use. Since it is not dependent on a compressed source for inflation, it is portable. There are four parts of the self-inflating bag (Fig. 29.1):

- Air inlet
- Oxygen inlet
- Patient outlet
- Valve assembly

AIR INLET

As the bag re-expands following compression, air is drawn into the bag through a one-way valve that may be located at either end of the bag, depending on its design. The opening for air is called air inlet.

OXYGEN INLET

Every inflating bag has an oxygen inlet, which is usually located near the air inlet. The oxygen inlet is a small nipple or projection to which oxygen tubing can be attached when oxygen is needed. In the self-inflating bag, an oxygen tube does not need to be attached in order for the bag to function. It has to be attached if the infant is to be resuscitated with an oxygen-enriched air mixture rather than with room air.

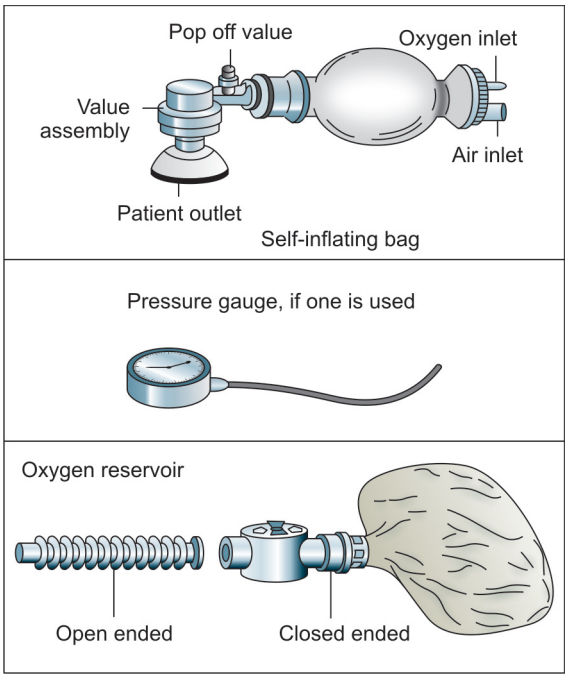

Fig. 29.1: Parts of self-inflating bag

PATIENT OUTLET

The patient outlet is where the air exits from the bag to the infant and is where the mask or endotracheal tube connector can be attached.

VALVE ASSEMBLY

Self-inflating bags have a valve assembly positioned between the bag and the patient outlet. When the bag is squeezed during ventilation, the valve opens, releasing oxygen/air to the lungs of patient. When the

bag re-inflates (during the exhalation phase of the cycle), the valve is closed. This prevents the patient's exhaled air from entering the bag and being rebreathed.

Optional Parts

Pressure Gauge

Some self-inflating bags have a site for attaching a pressure manometer/gauge. The attachment site usually consists of a small hole or projection close to the patient outlet. A pressure gauge is an extra piece of equipment attached to the bag by means of a small tube, at a point close to the patient outlet. It measures pressure generated by the bag in centimeters of water. This gauge allows the person using the bag to control the pressure of the air or oxygen being delivered to the patient.

PEEP Valve

An adjustable PEEP (positive end expiratory pressure) valve can be connected to valve assembly. It is useful if one is resuscitating extremely low birth weight baby (<1 kg) or if manual resuscitation for a baby disconnected from the ventilator is required.

Using Bag with Oxygen

All babies requiring positive pressure ventilation at birth should be ventilated with a bag capable of providing higher concentration of oxygen (90–100%) but in delivery room use of blenders for regulating oxygen is recommended. In term babies room air resuscitation can be initiated with back up facility for supplementing oxygen if baby does not improve following 90 seconds of room air administration. In preterm babies <32 weeks resuscitation can be initiated with bag attached to oxygen source connected with blender and FiO_2 between 21–30%. Because oxygen is considered to be a drug and its use in neonates must be carefully controlled, it is important to know the approximate concentration of oxygen being administered to an infant during resuscitation.

Remember that oxygen can be brought into a self-inflating bag through tubing connected to an oxygen source. Each time the bag re-inflates, room air is drawn into the bag by way of the air inlet. This means that even though hundred percent oxygen is flowing through the O_2 inlet, it is diluted by the room air that enters each time the bag re-inflates.

As a result, the concentration of oxygen actually received by the patient is greatly reduced, it is somewhere in the range of 40–70%.

Oxygen Reservoir

High concentrations of oxygen can be achieved with a self-inflating bag through the use of both the oxygen tubing and an oxygen reservoir. An oxygen reservoir is an appliance that can be attached over the bag's air inlet. This reservoir provides a chamber filled with a high concentration of oxygen. During re-inflation, instead of room air being drawn in, the bag draws the highly oxygen-enriched air in the reservoir. This permits administration of as high as 90–100% oxygen with a self-inflating bag.

This means that self-inflating bags without oxygen reservoirs are totally inadequate for resuscitation in the delivery room. Therefore, all self-inflating bags used in a delivery room must have oxygen reservoirs attached so that the bags are capable of delivering a high concentration of oxygen.

Safety Features

Two safety features are built into resuscitation bags to help control the amount of pressure that goes into the lungs. These safety mechanisms prevent high pressures being delivered inadvertently to lungs.

These safety features are:

- The pressure release valve
- The pressure gauge.

Any resuscitation bag used for neonates should have *at least one* of these above two features.

A *pressure release valve*, more commonly known as a pop-off or safety valve, is a feature that is built into many resuscitation bags. These pressure release valves are set to release at 30–40 cm of water. Therefore, if pressures in excess of this limit are generated, the valve opens, preventing the excess pressure from being transmitted to the infant.

In some self-inflating bags, the pop-off valve can be temporarily occluded or bypassed to allow pressure in excess of 40 cm of water to be administered. This may occasionally be necessary to effectively ventilate a neonate's non-aerated lung, especially with the first few breaths. Extreme care must be taken not to use excessive pressure during the few ventilations in which the pop-off valve is bypassed. Any self-inflating bag in which one can bypass the pop-off valve should have a pressure gauge attached to it.

Use

1. To provide intermittent positive pressure ventilation.
2. To provide peak end expiratory pressure in preterm.
3. To judge pressure required before connecting baby to ventilator.

Misuse

1. Never use bag for providing free flow of oxygen.
2. Excessive pressures may result in pneumothorax.
3. Prolonged ventilation may lead to oxygen toxicity if 100% oxygen is being provided.
4. In thick meconium-stained neonate, do not use bag and mask until airway is cleared.
5. In diaphragmatic hernia, bag and mask ventilation will lead to acute deterioration. Use endotracheal tube and bag for resuscitation.

RESUSCITATION MASKS

Masks come in a variety of shapes, sizes and materials. The selection of a specific mask for use with a particular infant will depend on how well the mask fits the infant's face and how easy it is to use in obtaining a seal. Resuscitation masks have rims that are either cushioned or non-cushioned.

***Non-cushioned*:** Some masks are constructed without a padded, soft rim. Such a mask usually has a very firm, abrupt edge to the rim.

- Because it does not easily conform to the shape of the baby's face, it requires greater pressure to form a seal than does a cushioned mask.
- It can damage the eyes if the mask is improperly positioned.
- It can bruise the neonate's face if the mask is applied too firmly.

***Cushioned*:** The soft rim on a cushioned mask from either a soft, flexible material, such as foam rubber, or an air-inflated ring. A cushioned rim mask has several advantages over a mask without a cushioned rim:

- The rim conforms more easily to the shape of the infant's face, making it easier to form a seal.
- It requires less pressure on the infant's face to obtain a seal.
- There is less chance of damaging the infant's eyes, if the mask is incorrectly positioned.

Shape

Masks come in two shapes:

- Round
- Anatomically shaped.

***Round*:** A round mask can be effective in obtaining a seal for ventilation. If the correct size is not selected, a seal cannot be formed, or it may not fit over the mouth and nose correctly. If the mask is too large, pressure may be exerted on the eyes and can cause damage.

***Anatomically shaped*:** Some masks are shaped to fit the contours of the face. These masks are referred to as anatomically shaped masks. They are made to be placed on the face in a particular direction with the most pointed part of the mask fitting over the nose. It is easier to obtain a seal with an anatomical mask.

TABLE 29.1: Common resuscitation bags available in the market

S. No	*Make*	*Dealer*	*Unit cost (₹)*
1.	Silicone (indigenous)	Meditrin Mediserve Zeal Medical, Phoenix Med, Delhi Hospital Supply	1000–1400
2.	Ambu bag (imported)	Indian Surgicals Equipment Mediland Surgifield	3500–4500
3.	Silicone Laerdal Make	Delhi Surgical Dressings	4000–5000
4.	Silicone Taiwan Make	Rustagi Surgicals, Hoenix Medical Systems	2800–3500
5.	Silicone Korean Make	Delhi Hospital Supply	2400
6.	Silicone Ambu Make	Indian Surgicals Equipment	4000–5000

Size

Masks come in several sizes. Resuscitation tray should contain masks suitable for small premature infants as well as for full-term infants. For the masks to be correct size, the rim must cover the tip of the chin, the mouth, and the nose, but not the eyes.

- Too large a mask will lead to ineffective seal and possible eye damage.
- Too small a mask will not cover the mouth and nose and may occlude the nose.

Decontamination

***Washing and rinsing*:** Thorough decontamination of the resuscitator is necessary, ideally after each use. Disassemble all parts. Wash thoroughly in warm water using a detergent that is compatible with the resuscitator materials. Rinse all the parts thoroughly in clean water. Dry them before reassembling.

***Disinfection/sterilization*:** Disinfection is the process by which all the live organisms get killed while in sterilization even the spores are killed. Chemical disinfection can be done by soaking in 2% glutaraldehyde active solution for 20 minutes. Sterilization procedure takes at least 6 hours. One can use ethylene oxide for gas sterilization, while boiling and autoclaving can be used for all disassembled parts of resuscitator except the reservoir. All parts should be dried before reassembling. If detergent disinfectant residuals are allowed to dry on the resuscitator parts, the surface may become sticky. This may cause valve malfunction. Carefully inspect all parts for damage or excessive wear and replace them, if required. Reassemble and test the bag for proper functioning. Common brands available in India are shown in Table 29.1.

Frequently Asked Questions (FAQs)

Q. 1. What should I look for before buying a resuscitation bag?

Ensure that it is capable of providing 100% oxygen, has a safety device inbuilt and it conforms to standard specifications (like patient outlet fixes to connectors of standard endotracheal tubes and other brands of masks).

Q. 2. What is the ideal capacity of a resuscitation bag for newborn?

Ideal capacity of a bag for a neonate is 240–750 ml. For a baby <1500 g use a bag of 240–350 ml capacity.

Q. 3. Can I use resuscitation bag for providing free flow of oxygen, if oxygen is connected to oxygen inlet?

Not all types of bags can be used for providing free flow of oxygen. Only bags with closed end

reservoir or anesthesia bag may be used for this purpose.

Q. 4. How does self-inflating bag score over anesthesia bag?

Self-inflating bag is ready to use in emergency even if there is no supply of oxygen or pressurized gas. The concentration of oxygen can be varied with or without reservoir from 90–95% to 45–60% respectively. On the other hand, anesthesia bag always requires pressurized source of air or oxygen. If connected to oxygen it can deliver only 100% oxygen.

Q. 5. What are the indications and contraindications of bag and mask ventilation at birth?

Indications

a. Baby is apneic or gasping after initial steps of resuscitation.
b. Heart rate <100/minute.
c. Central cyanosis not improving with free flow of oxygen.

Contraindications

a. Meconium stained amniotic fluid with baby depressed at birth.
b. Congenital diaphragmatic hernia.

Q. 6. How can I judge for myself the amount of pressure I am able to generate with my hand?

You may train your hands and finger by simple test. Attach a long intravenous tube to patient outlet with an endotracheal tube connector. Let the tube dip to 15 cm under water level. Your fingers will have to generate pressure more than 15 cm, so as to cause air bubbles to be generated under the water column. Now let tube end sink to 20 cm below water level, you will have to generate more than 20 cm of water pressure. Similarly, one can judge for pressures of 25, 30 and 35 cm of H_2O, etc.

One can attach a manometer to patient outlet and read directly on a dial (1 mm of Hg = 1.3 cm of H_2O). Or if bag has a facility of pop off safety valve, one will have to exceed pressure of pop-off limit say 30 cm of H_2O when the hissing sound appears.

Q. 7. In an open-ended reservoir why is the tube corrugated?

Open-ended reservoir is provided with corrugations for increasing the volume of reservoir and when oxygen gets consumed from reservoir, it is drawn inside the bag in a laminar fashion.

Q. 8. What are ideal specifications of resuscitation bag?

Many locally made resuscitation bags are available which do not conform to ideal specifications. A few of them are highly unsatisfactory because of the poor quality of rubber, lack of facility for attachment of reservoir, absence of any safety features and loss of re-expansion of bag with use. Masks do not fit well at patient outlet and tight seal is difficult to obtain. Look for the following before purchasing a resuscitation bag for a newborn:

a. Capacity of bag (ideal 240–750 ml)
b. Provision for attaching reservoir
c. Safety device is present
d. Patient outlet is of standard size; endotracheal tube connectors and standard masks fit well into it
e. Easy to clean and disinfect
f. Withstands repeated autoclaving and boiling.

Q. 9. What is the function of valve adapter connected between air inlet and the closed-ended reservoir?

The valve adapter has the following functions

a. It regulates the pressure generated inside the bag. Once the reservoir is filled with oxygen the valve at air inlet and inspiratory valve at air outlet opens, so that continuous flow of oxygen is achieved. It results in PEEP of 2–3 cm of H_2O.
b. In case reservoir is completely full of oxygen, excess oxygen leaks from valve adapter to atmosphere.

c. In situations when there is no oxygen in the reservoir, while bag re-inflates air is drawn in through the openings on valve adapter, thus delivering at least room air for resuscitation.

Q. 10. How often should one disinfect/sterilize bag and mask equipment?

This depends on number of babies needing bag and mask ventilation. Ensure that if it is used for a baby born following frank chorioamnionitis, the equipment needs sterilization before being used on next baby. In a busy hospital catering for 2000 births per annum, it may be a good idea to sterilize bag and mask every 15 days. But disinfection must be followed on daily basis. The mask must be disinfected after each single use.

Q. 11. What is sustained lung inflation?

During first few breaths of manual ventilation after birth providing initial inflation of 5–15 seconds at inflating pressure of 20–25 cm of H_2O. It increases the functional residual capacity, aeration of lung and stabilizes cerebral oxygen delivery. It is still restricted to randomized trials.