Clinical Topics

Mechanical aids to ventilation for use in the field

M G HARRIES

British Medical Journal, 1979, 2, 426-428

Efficient management of the airway is essential in such emergencies as head injury, electric shock, suffocation by smoke, asphyxiation by drowning, cardiac arrest, or epilepsy, and some of the mechanical aids evaluated below are useful on occasions when assisted ventilation is required in the field. Their use demands different levels of experience ranging from basic skill for Brook airways to more advanced for mechanical ventilators.

There is no substitute for basic cardiopulmonary resuscitation performed in a competent manner, but mechanical aids are invaluable in the hands of those who are trained to use them. There are two advantages. Firstly, using such devices to improve the airway allows the operator to perform expired air resuscitation without having to suffer the unpleasantness of placing his lips directly over the patient's mouth. Secondly, and more important, mechanical aids permit the use of oxygen, which is vital when treating severely hypoxic patients.

Devices that improve the airway

BROOK AIRWAY

The Brook airway is the simplest device available and can be used in the field by any trained first-aider. It comes with either a long or a short mouthpiece and has two portions: a short curved blade which goes into the victim's mouth, separated from an extension to the mouth of the resuscitator by a curved plastic shield; and a one-way valve which directs the patient's exhaled breath away from the operator's face. The airway is inserted over the tongue until it is about halfway in and then rotated and pushed gently until the plastic shield seals firmly against the patient's lips (fig 1), the mouth is held closed with the fingers gripping the shield against the face, the neck is fully extended, and the nose is pinched off. Rise and fall of the chest means that air is entering the lungs and not the stomach.

PHARYNGEAL AIRWAYS

Using a pharyngeal airway requires a little more skill than the Brook airway and is slightly more complicated. Nevertheless, it has proved a tremendous success in other parts of the world because it is such a reliable way of providing a clear open air passage. A Sri Lankan, Dr Don Michael, invented the airway

FIG 1—The Brook Airway in place with the neck extended. The shield is held tight against the lips and the nose is pinched off with the other hand.

FIG 2—The oesophageal obturator airway with the balloon fully inflated. The face mask is not included.

while he was professor of medicine in Iran, and a description was published in the *Lancet* at that time.¹ One advantage is that because the airway is passed into the oesophagus with the head flexed, no laryngoscope is required. The tube is obstructed at the lower end and is lodged in place by an inflatable balloon (fig 2). Air blown down the tube escapes through holes cut through the portion which lies in the oropharynx and, with a tight-fitting mask in place, this air passes down the trachea. The beauty of Dr Michael's invention is that the obstruction of the oesophagus prevents the patient from inhaling vomit, while it also prevents the stomach from being inflated with air during the resuscitation procedure.

This device has been developed and used by the California Paramedic Service with great success and figures from Los Angeles and Orange County show that the airway has been

Cardiothoracic Institute, London SW3 6HP

M G HARRIES, MB, MRCP, lecturer (present appointments): lecturer, department of medicine, Guy's Hospital, London SE1 9RT, and medical adviser, World Life Saving Association)

passed a total of 30 336 times.² The operator fails to pass the tube in only 5% of cases. There have been three reports of oesophageal damage arising from the use of these airways,³⁻⁵ usually from improper use. Though these devices are easy to use and effective, they have not yet been accepted in Britain and no one here has been trained in their use.

On the other hand, endotracheal tubes (laryngeal airways) are more complicated and are beyond the skill of most competent ambulancemen and firemen. They are therefore unsatisfactory for using in the field.

Devices that improve ventilation

Mechanical ventilation devices can be used with or without an artificial airway in place. All require the use of a mask which needs to be applied to the face and nose with a good seal. Jaw thrust—which is a more difficult technique than jaw lift, but can be done by a trained operator—is used to hold the mask in place and is best performed with the operator at the head of the patient. This is quite different from the jaw lift used exclusively for cardiopulmonary resuscitation without mechanical aids of any kind, where the operator kneels at the patient's side, and lifts the chin with one hand. In jaw thrust the mandible is lifted by hooking the fingers around the angle of the jaw and displaced forward by the thumbs or index fingers on each side. The mask should be transparent or semi-transparent so that the airway may be kept under constant observation. Lay people have no trouble in learning to produce adequate ventilation using the mouth to mask method with jaw thrust, provided that both hands are kept on the mandible (fig 3).

FIG 3—Mouth to mask resuscitation using jaw thrust.

OXYGEN INHALATORS

Oxygen inhalators are not resuscitators and must never be used on patients who are not already breathing spontaneously. Every patient who has stopped breathing will be hypoxic, and the treatment for hypoxia is oxygen. It is very difficult to tell from his appearance whether or not a patient is hypoxic, and some victims of immersion, although fully conscious, are found to be severely hypoxic on arrival in hospital: this hypoxia may last for many hours.⁶

Continuous oxygen treatment should be given to all survivors of respiratory or cardiac arrest once they are breathing spontaneously, and many devices for use in the field are available which supply oxygen in this way. Typically, they consist of a small oxygen cylinder and a polyethylene mask, and are called oxygen inhalators (fig 4). The concentration of oxygen supplied to the patient depends on the flow rate from the cylinder and the design of the mask. Hypoxic patients need as much oxygen as

FIG 4—Oxygen inhalator with polymask and cylinder reservoir.

possible, and a few devices of this sort will supply an oxygen concentration of greater than 60% with a flow rate of 8 litres a minute. Non-breathing patients will require assistance with a mechanical ventilator.

BAG VALVE MASK RESUSCITATORS

Bag valve mask resuscitators or hand-operated ventilators share a common design—they all have a reservoir bag which can be filled with oxygen if necessary, a one-way valve at the mask, and a transparent face mask. Ideally, it should be possible for an operator to squeeze a volume of at least 1 litre from the bag with one hand while holding the mask on the face with the other. In practice, however, this is very difficult to do for all except the most highly trained because it is almost impossible to get an adequate seal with the mask at the mouth. This equipment is invaluable in the hospital operating theatre in the hands of an anaesthetist, for whom of course it was designed, but it is not recommended for use at the accident site.

MECHANICAL OXYGEN POWERED VENTILATORS

Mechanical ventilators are used in the management of unconscious non-breathing patients and it is essential that they can be used in conjunction with heart massage. The current recommendations of the American Heart Association and the World Lifesaving Association^{7,8} are that heart massage is performed at a rate of 60 compressions a minute with an inflation given every fifth beat with no pause in the massage rhythm for the breath. This allows less than one second to get the breath in, which means that if the patient is to receive at least 1 litre per breath, the ventilator will need to supply oxygen at a flow rate of at least 60 litres per minute. It is clear that if the inflation is to be given at precisely the right moment, remembering that there should be no pause in the massage rhythm for the breath, a ventilator triggered by hand is the *only* device that is acceptable. The internationally agreed minimum standards for an automatic oxygen powered ventilator are:

- (1) It should be manually triggered.
- (2) It should give a minimum flow rate of 100 litres oxygen per minute.
- (3) It should deliver oxygen at 100% concentration.

Some mechanical ventilators are automatically cycled by changes in pressure in the chest and these are referred to as pressure-cycled machines. They are incompatible with cardiac massage because each compression of the chest results in switching the pressure-sensitive valve from inspiration to expiration. No pressure-cycled machine supplies an oxygen flow rate of anything approaching 60 litres per minute, let alone

100. Such machines are of no practical value and should not be used.

Only three ventilators which satisfy the international standards already set out are available in Britain: these are the Hudson, the Robertshaw, and the Flynn (fig 5). Both the Hudson and the Robertshaw resuscitators are demand valves, which means that they will deliver oxygen to the lungs automatically if the patient attempts to take a breath. They are not particularly reliable during use in the field because of their complex design. The Flynn valve has proved to be remarkably reliable all over the world, is simple and straightforward to use, and there have been no reported failures.⁹

FIG 5—Flynn manually triggered resuscitator with transparent face mask.

ASPIRATORS

There are some serious objections to using mechanical aspirators. If needed at all, they are needed to clear vomit from the oropharynx, but oxygen-powered or foot-controlled suckers do not generate a sufficient vacuum to clear solid matter. In

addition, they are often powered from the same oxygen source that powers the ventilator; this so depletes the oxygen supply that the ventilator may run for only five minutes or less. More worrying is the fact that they provide a further distraction at a time when the operator should be clearing the airway with his fingers and getting on with the important business of ventilating the patient.

Conclusions

Fundamental training in basic heart/lung resuscitation is an essential prerequisite to managing a patient who is not breathing. Once trained in these basic techniques, the use of appropriate mechanical aids may be life saving.

The simpler devices such as the Brook airway and a face mask are suitable for use by a first-aider with little training. The use of pharyngeal airways, in my opinion, has not yet received sufficient evaluation in Britain, but they have proved indispensable in the hands of the California Paramedic Service.

I must emphasise that pressure-cycled mechanical ventilators have no place in emergency resuscitation in the field because they are incompatible with cardiac massage.

Sets of slide/tapes, one on basic cardiopulmonary resuscitation and the other on the use of mechanical aids, are available from Graves Medical Audiovisual Library, PO Box 99, Chelmsford, Essex (a non-profitmaking, charitable organisation).

References

- 1 Don Michael, T A, *Lancet*, 1968, **2**, 1329.
- 2 Gordon Archer, S, from *Advances in CPR*, ed Peter Safer. New York, Springer-Verlag, 1977.
- 3 Pilcher, D B, DeMeules, J E, *Chest*, 1976, **69**, 377.
- 4 Strate, R G, Fischer, R P, *Journal of Trauma*, 1976, **16**:6, 503.
- 5 Carlson, W J, Hunter, G W, and Bonnabeau, R C, *Journal of the American Medical Association*, 1979, **241**, 1154.
- 6 Modell, J H, Graves, S A, Ketover, A, *Chest*, 1976, **70**, 231.
- 7 American Heart Association, *Journal of the American Medical Association*, 1974, **227**, No 7 (suppl).
- 8 World Life Saving Medical Advisory Panel, 1978, *Life Saving World*, 1978, **1**, No 4, 24.
- 9 Harries, M G, *Practitioner*, 1978, **221**, 616.

MATERIA NON MEDICA

Prayer and healing

The morning prayers of the Jews include the invocation "Creator of remedies, revered in praise, Lord of wonders, who renews each day in his goodness, the works of creation." Orthodox Jews interpret these words characteristically: when sick go to a doctor, for the Lord has created the appropriate medicines. If you are not helped say the Psalms in hope, because they excel in praise of the Lord and give succour to body and soul. However, if the illness still persists pray for a miracle to the Lord of wonders.

I have patients who literally follow all three precepts, usually successively, but occasionally together. When a religious person is seriously ill or undergoing major surgery his relatives and friends will chant with fervour a selection of the Psalms. One Saturday morning we had completed the Sabbath Service at the Western Wall of the Temple Mount in Jerusalem. The brother of a young woman who was in the throes of a complicated labour handed each of us a Book of Psalms. Together, we read aloud a relevant selection. The following week we were told the labour had ended successfully for mother and child.

I have a patient with severe incapacitating angina pectoris, with corresponding blocks on coronary angiography. The consultant cardiologist and heart surgeon strongly recommend surgery. The patient agreed and a date was set. Friends suggested to him that he consult a medical practitioner specialising in vegetarian therapy. The patient told me that the practitioner promised him a cure in 45 days.

This seemed to be too good to be true to the sufferer, so he consulted a Rabbi with a national reputation for wise advice who acts as the referee on medical problems for a huge flock. The Rabbi's rooms were crowded with patients checking on their medical advice. The Rabbi listened carefully and requested to be told exactly what each doctor had said. He then gave his opinion. "The vegetarian diet will not cure you. Pay no attention to that doctor. Do exactly what your own doctor advises in consultation with the cardiologist and surgeon."

Perhaps the most stirring prayer for healing in all literature is found in Numbers 12:13. Miriam had been stricken with leprosy and Moses prayed for her recovery in five Hebrew words of one syllable each, whose phonetic rendering is "El na r'fa na la." A translation, in five words of one syllable is "O god, pray heal her."

The previous chapters of Numbers give the poignant request of Moses for a mercy killing, indeed a request for euthanasia. "And Moses said unto the Lord . . . I am not able to bear all this people alone, as it is too heavy for me. And if thou deal thus with me, pray kill me if I have found favour in thy sight, and let me not see my wretchedness. . . ."

"And the Lord said unto Moses . . . "And I will come down and talk with thee there."

The Lord advised Moses to share his burden and delegate some of the responsibilities. In addition to these practical measures there was full communication, with the healer coming to patient. If this example were followed the requests for euthanasia would diminish markedly. —ELI DAVIS (physician, Jerusalem).