ABC of Resuscitation

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THE AIRWAY AT RISK

Failure to maintain a patent airway is a common cause of avoidable death in unconscious patients. The principles of airway management after cardiac arrest are the same as those used during anaesthesia or resuscitation after major trauma. Patency of the airway may be impaired by loss of normal muscle tone or by obstruction, including contamination by foreign material from the mouth, nasopharynx, oesophagus, or stomach.

Airway clearance

Opening the airway

In the unconscious patient relaxation of the tongue, neck, and pharyngeal muscles causes soft tissue obstruction of the supraglottic airway. Correction using long established manoeuvres includes head tilt and jaw lift or jaw thrust. The use of neck lift to produce head tilt is widely recommended in first aid manuals, but it leaves one hand committed behind the neck and it may be dangerous in the presence of an unstable injury of the cervical spine. Head tilt will relieve obstruction in 80% of patients and jaw lift or jaw thrust will further improve overall patency but tends to oppose the lips. In some of these patients airway obstruction may persist, particularly during expiration, probably because of nasal airway obstruction caused by a "flap-valve" effect of soft palate and nasopharyngeal tissues, as in the snoring subject.

The triple manoeuvre (Safar) requires the rescuer to open the mouth while performing head tilt and jaw thrust. It is difficult to maintain especially when performing artificial respiration at the same time.

Recovery posture

Patients with adequate spontaneous ventilation and circulation but who cannot safeguard their own airway will be at risk in the supine position. Turning the patient laterally into the "coma" or "recovery" position allows the tongue to fall forward, with less risk of pharyngeal obstruction, and fluid in the mouth can drain out instead of soiling the trachea and lungs.

Recovery positions range from a true lateral posture (with either upper or lower leg flexed) to the semiprone, depending on the relative tilt of the pelvis and shoulders and the attitude of the arms. Several authorities favour the lower arm extended behind the back to prevent reverse roll. The semiprone posture has been preferred as producing better airway patency and drainage and greater stability during transport. However, it is more difficult to observe the casualty's face, colour, and chest movement in this position and ventilation may be impaired. Moreover, the patient is inconveniently positioned if he has to be turned supine again for further resuscitation.

The subject may lie on either side. Some argue that emergency tracheal intubation may be performed more easily with the patient lying on his left rather than right side, but a full stomach is more liable to compression and

Heimlich manoeuvre.

Cricoid pressure.

Cricothyrotomy.

regurgitation in this position. First aid texts recommend that unconscious patients with associated chest injuries are best positioned with the uninjured lung uppermost. The complex pathophysiology of thoracic injury suggests that there may be some circumstances in which this may not be appropriate.

Casualties with spinal injuries need careful handling and should be managed in the supine aligned position with constant attention to the airway. If the recovery posture has to be adopted the patient should be turned into a true lateral position by several rescuers in unison to avoid spinal rotation. The semiprone position is not suitable in these circumstances because considerable rotation of the neck is required to prevent the subject lying on his face.

Vomiting and regurgitation

Rescuers should always be aware of the hazard of contamination of the unprotected airway by fluid or solid debris and attempt to forestall it. Vomiting and regurgitation are subtly different.

Vomiting happens more commonly during light levels of unconsciousness and may occur as the level of consciousness improves during successful resuscitation. It is an active process of stomach contraction and retrograde propulsion up the oesophagus. Prodromal retching may allow time to put the patient in the lateral recovery position or head down (Trendelenburg) tilt and prepare for suction or manual removal of debris from the mouth and pharynx.

Regurgitation is a passive and often silent flow of stomach contents (typically fluid) up the oesophagus, with the risk of unprotected inhalation and soiling of the lungs. Acidic gastric fluid may cause a severe chemical pneumonitis. Failure to maintain a clear airway during spontaneous respiration may also encourage regurgitation because the excessive negative intrathoracic pressure developed during obstructed inspiration may aspirate gastric contents across a weak mucosal flap valve from the stomach to oesophagus. Recent food or fluid ingestion, obesity, hiatus hernia, intestinal obstruction, and late pregnancy all make regurgitation more likely to occur during resuscitation. Cardiac compression and the use of abdominal binders or counterpulsation also add to the hazard of regurgitation.

Gaseous distension of the stomach increases the likelihood of regurgitation and restricts lung expansion. Inadvertent gastric inflation may arise during artificial respiration when rapid lung ventilation with large tidal volumes and high inflation pressures are used. This is particularly likely when gas powered resuscitators are used with a facemask. The current emphasis on rapid incremental breaths and synchronous combined ventilation-compression can also produce high inspiratory pressures.

The cricoid pressure manoeuvre, recommended by Sellick in 1961, is well known to anaesthetists. Compressing the oesophagus between the cricoid ring and the sixth cervical vertebra prevents passive regurgitation, but it should not be applied during active vomiting. It also serves a useful purpose during resuscitation in preventing undesired gastric inflation but will require the help of another rescuer.

Choking

Asphyxia due to impaction of food or a foreign body in the upper airway is a dramatic and frightening event and may closely resemble a heart attack. It requires urgent action to avert a catastrophe. In the conscious patient back blows and Heimlich abdominal thrusts have been widely recommended. Attempts may be made to provoke coughing or vomiting. If these are not successful the patient will become unconscious and collapse. The supine casualty may be given further abdominal thrusts and manual attempts at pharyngeal disimpaction should be undertaken. Visual inspection of the throat with a laryngoscope and the use of Magill forceps or suction is desirable, but such equipment is seldom available at the time of need.

If resuscitation so far has been unsuccessful the ultimate hypoxic arrest may be indistinguishable from other causes of cardiac arrest and treatment should be along standard lines, although ventilation may be difficult or impossible to perform. On the other hand, the act of forceful chest compression may clear the offending object from the laryngopharynx.

The desperate and heroic manoeuvre of cricothyrotomy (laryngotomy) may be lifesaving and should not be unduly delayed. Any strong sharp knife, scissor point, large bore cannula, or similar instrument can be used to create an opening through the cricothyroid membrane, although purpose designed cricothyrotomy devices are best if available. Once created, the opening needs to be maintained by some means. Artificial ventilation may be applied directly to this orifice.

The formal procedure of tracheostomy is technically difficult and should not be undertaken under adverse conditions.

Suction

Equipment for suction clearance of the oropharynx and airways is essential for comprehensive life support. When reviewing the many devices available, considerations of cost, portability, and power supply are paramount. Devices powered by electricity or compressed gas are susceptible to exhaustion of the power supply at a critical time, and battery operated devices need regular recharging or battery replacement. Hand or foot operated pumps are particularly suitable for field use and for the occasional user. Ease of cleaning and simple reassembly are important factors. The use of rigid, wide bore plastic or metal suction cannulae can be supplemented by soft plastic suction catheters when necessary. A "suction booster," which traps fluid debris in a reservoir close to the patient, may improve suction capability.

The airway during artificial ventilation

If, despite adequate clearance of the patient's airway, spontaneous respiration is absent artificial ventilation must be started. Earlier manual methods have been universally superseded by intermittent positive pressure techniques which produce better ventilation.

Expired air ventilation

Expired air ventilation exploits the rescuer's expired air to achieve good lung expansion, and, although less rich in oxygen than ambient air (16% v 21%), the resulting oxygenation is adequate.

The mouth to mouth technique is widely acclaimed and can be successfully applied by relatively unskilled rescuers. Nevertheless, during its performance it is difficult for the rescuer concurrently to maintain airway patency, effect an airtight seal with his lips, pinch the nose, and also deliver an adequate ventilatory volume.

An alternative route is mouth to nose ventilation, which until recently has been popular only with water lifesavers. This method permits maximum head extension and jaw thrust while usefully effecting lip closure. It may be the only option for small mouthed rescuers. Contact with vomit, saliva, etc, is reduced, which may make mouth to nose ventilation more acceptable and lessen the risk of infection. Natural nasal resistance limits high inspiratory flow, which might otherwise lead to gastric inflation. If nasopharyngeal obstruction is noted during expiration the rescuer may need to open the casualty's mouth to allow exhalation.

Ventilation masks

Ventilation masks offer some protection to the rescuer. The rescuer blows through a mask firmly applied to the casualty's face. An example is the transparent Laerdal pocket mask, which has a rescuer mouthpiece and a pneumatic cuff. During expired air resuscitation the rescuer uses two hands to maintain an airtight seal with the mask on the face while also lifting the jaw.

Air flow generally occurs through the nose. Unless oral or nasal airway support devices are used, obstructed expiration may go unrecognised in some subjects.

A self refilling bag can be attached to the mask to deliver ambient air, and this can be enriched with oxygen if a source of compressed oxygen is available. The technique requires additional training because it is difficult to apply the mask and lift the jaw with one hand while squeezing the bag with the other.

Airway support and ventilation devices

Artificial airways can be used to maintain patency and improve spontaneous breathing and may also provide a mouthpiece for artificial ventilation if required. Some afford protection to the rescuer against infection and some isolate the airway against pulmonary soiling from gastric aspiration.

The classic Guedel airway used in anaesthesia improves patency but often requires supplementary jaw support. In lightly comatose patients it may cause oropharyngeal stimulation and vomiting. Soft nasopharyngeal tubes are less stimulating but may cause nasopharyngeal bleeding, and they need some skill in insertion. These simple airways are also suitable for use with mask ventilation.

Rescuer protection

There is concern about the risk of infection associated with mouth to mouth ventilation and an increasing public demand for small and inexpensive airway adjuncts which will protect against communicable diseases.

A simple expedient is to blow through a handkerchief moulded over the patient's face. An extension of this concept is the Resusciade, which comprises a plastic sheet incorporating a central bite block with a one way patient valve.

The Safar S shaped reversible double airway consists of a medium and a large Guedel airway placed back to back. The uninserted airway provides a port for expired air ventilation if required and provides some protection for the rescuer.

The Brook airway was developed to provide rescuer protection using a non-return valve. The valve may be lost if the unit is dismantled, and the air flow resistance for rescuer and victim alike is high. The All purpose model is easy to insert but offers no effective tongue support. The Professional model has a longer (7 cm) airway, which provides limited tongue support.

More recently new ventilation devices have become available with improved valves for rescuer protection. These either incorporate a mask element—for example, MTM resuscitator and SealEasy/VentEasy mask—or a tongue support tube—for example, Sussex airway. An ingenious Dual-Aid airway capable of airway support and ventilation has the advantage of optional use through the nose or mouth.

Device	Manufacturer	Cost
(1) Sussex valve airway	Tandisdale Medical, Forest Row, Sussex, UK	
(2) Dual-Aid	Vitalograph Ltd, Buckingham, UK	£6.75
(3) Safar S airway	Portex Ltd, Hythe, Kent, UK	£3.47
(4) Brook airway (All purpose model)	G H Wood, Toronto, Canada	£10.37
(5) Laerdal pocket mask	Laerdal Medical, Stavenger, Norway	£3.00
(6) SealEasy/VentEasy mask-airway	Respironics, Monroeville, PA 15146, USA	£10.00
(7) Resusciade	Portex Ltd, Hythe, Kent, UK	£1.05
(8) MTM Resuscitator	Racal Safety Ltd, Wembley, Middlesex, UK	£9.00

Airway isolation

The ultimate in airway management in deeply unconscious patients is tracheal intubation, which requires experience and specific equipment. Traditionally the forté of anaesthetists, this skill has been learnt by emergency medical staff, specialist nurses, and skilled paramedics such as ambulance crews. The technique essentially involves flexing the subject's neck, extending his head, exposing the epiglottis with a laryngoscope, forward elevation of the jaw and base of tongue to expose the larynx, and inserting a curved tube into the trachea. Inflation of the tracheal cuff isolates the airway and enables safe ventilation to be performed. The risks are those of stimulating vomiting in the semiconscious patient, trauma to mouth and larynx, unilateral bronchial intubation, and unrecognised intubation of the oesophagus.

If attempts at tracheal intubation are unsuccessful they must be abandoned without delay and alternative methods of airway control chosen. Techniques for tracheal intubation have been advocated which avoid formal laryngoscopy but these have limited success even in experienced hands. They include blind nasal intubation, digital manipulation of the tube in the laryngopharynx, or transillumination using lighted tube stylets. One interesting development is a laryngeal tube mask which fits snugly in the hypopharynx to isolate the laryngeal inlet.

Oesophageal obturators

Oesophageal obturators are popular in the USA. The obturator is a long cuffed tube attached to a facemask. The tube is passed blindly into the oesophagus and the cuff is then inflated to isolate the oesophagus and stomach from the airway. In the original version the oesophageal obturator tube is blocked distally and a series of holes at laryngeal level permit air blown down the tube to pass from the tube into the larynx. In a later version the oesophageal tube is not terminally sealed and this allows for aspiration or pressure relief of gastric contents. A second orifice in the mask is used for ventilation. Hazards in the use of these tubes include trauma to the oesophagus and stomach, the risk of inducing vomiting and gastric rupture, and, paradoxically, the rare occurrence of unrecognised tracheal intubation.

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Epidemiology

An outbreak of gastrointestinal illness associated with consumption of raw depurated oysters

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A lunch time reception was held in March 1985 for French visitors as part of a twin town celebration at which a seafood menu which included raw oysters was served. The next day, while the French visitors travelled home, some of the English guests became ill with diarrhoea, abdominal pain, and vomiting, and an investigation was begun.

Methods

A cohort study was conducted using a short postal questionnaire which asked about the foods eaten, occurrence of illness, and the nature and onset time of symptoms. After consultation with the French Department of Health a translated questionnaire was delivered to each of the French visitors via their local mayor.

Faecal samples collected from four guests several days after onset of illness were examined bacteriologically. The source, trans-

portation, storage, and preparation of each of the foods were documented, and the relevant premises visited and examined. Bacterial monitoring records from the oyster fishery were reviewed.

Results

Replies were received from all of the 29 English guests and from 22 of the 25 French guests. Of the 51 responders, 13 (25%) became ill within 48 hours of the meal (median incubation period was 36 hours) and a further three suffered gastrointestinal upset during the week after the reception. The main clinical features were diarrhoea, nausea, and loss of appetite, and half those affected also complained of vomiting.

For the calculation of food specific attack rates a case definition of diarrhoea, abdominal pain, or vomiting beginning within 48 hours of the reception was used; those whose illness did not meet the case definition were excluded from the analysis. Very few people drank non-alcoholic beverages, and of the six available food items, only the oysters were significantly associated with illness (table); all of the 13

Food specific attack rates

Food	Number		Number		Probability (Fisher's exact test two tailed)
	Who ate*	Ill (%)	Who did not eat*	Ill (%)	
Fish balls	41	13 (32)	5	0	NS
Tomato dressing	26	9 (35)	19	4 (21)	NS
Mussels	42	12 (29)	5	1 (20)	NS
Cockles	43	13 (30)	3	0	NS
Oysters	36	13 (36)	10	0	p<0.01
Prawns	43	12 (28)	1	0	NS

*Excluding people who did not reply to particular food items.
NS=not significant, all >0.2.

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