Principles of Urgent Management of Acute Airway Obstruction

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KEYWORDS
- Airway obstruction • Foreign bodies • Complications • Tracheostomy • Laryngoscopy

KEY POINTS
- Have knowledge of features of airway compromise and identify and treat patients with airway obstruction early.
- Use of simple airway maneuvers will often achieve a patent airway. Oxygenation is important; try to provide a high oxygen concentration.
- Delivering oxygen at the mouth that does not reach the alveolus is not a treatment for airway obstruction. Recognize the dangerous sequelae of hypoxia and aspiration.
- Call for help early and prepare for intubation in a timely fashion. Always be ready to perform tracheostomy and/or surgical tracheal intubation/tracheostomy.

INTRODUCTION
By appreciating the causes of an obstructed airway, treatment with oxygen and other simple maneuvers can be delivered swiftly, preserving airway patency and passage of oxygen to the lungs for ventilation. Airway obstruction results in hypoventilation, increased work of breathing, and impaired gas exchange with the development of hypercarbia and ultimately hypoxemia if left unresolved.

Obstruction may be partial or complete, depending on the mechanism or cause. Complete airway obstruction will rapidly cause hypoxia and cardiac arrest, whereas partial obstruction may be more insidious in onset. Reduced alveolar ventilation in the obtunded patient and the obstructed airway leads to hypercapnea, respiratory acidosis, and hypoxemia. Noisy breathing characterizes a partially obstructed airway, and complete absence of airway noises points to total airway obstruction.

In this article, the upper and lower airways' anatomy, airway reflexes, airway obstruction, and the related treatment methods are discussed and the updated literature is reviewed. The literature is summarized in Tables 1 and 2. After discussing the topic in the light of literature, principal steps for the urgent management and handling of airway obstruction are presented in an algorithm.

ANATOMY AND PHYSIOLOGY

Functional Anatomy
Most airways are deformable, not rigid, and are affected by mechanical forces and pressures impinging on the wall. Muscle, blood vessels, and glands in the airway wall are under local and reflex control, and actively respond to changes in the internal and external environments.

The respiratory tract is divided into 2 broad divisions: the upper and lower airways. The upper airways (Fig. 1) consist of the extrathoracic structures from the nares and mouth down to, and including, the larynx. The lower airways (see
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<th>Age</th>
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<tr>
<td>&lt;3 y</td>
<td>Laryngotracheobronchial (the right bronchus</td>
<td>Toys, sweets, batteries, jewels, rocks, and magnets</td>
<td>• Shortness of breath</td>
<td>Bronchoscopy</td>
<td>Amer et al, 2017</td>
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<td></td>
<td>(61.4%), left main bronchus (31.6%), trachea</td>
<td></td>
<td>• Stridor, cyanosis</td>
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<td></td>
<td>(5.3%), larynx (1.7%)</td>
<td></td>
<td>• Cough, fever, and, chest rhonchi</td>
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<td>4 y and 5 y</td>
<td>Hard palate</td>
<td>Penetrating FBs</td>
<td>• Agitated child in open mouth posture</td>
<td>Orotracheal intubation and orotracheal intubation + midlevel emergency tracheostomy</td>
<td>Edem et al, 2017</td>
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<td></td>
<td>2 cm over the cricothyroid membrane</td>
<td></td>
<td>• Swollen neck and difficulty in breathing</td>
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<td>Mean age 3.7 y</td>
<td>The main stem bronchus (62.5%)</td>
<td>Airway FBs</td>
<td>—</td>
<td>Tracheostomy (5.7%) and bronchoscopy (65.4%)</td>
<td>Roberts et al, 2017</td>
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<td>0.6–18.8 y</td>
<td>Airways</td>
<td>Airway FBs</td>
<td>Complicated (19.6%)</td>
<td>Bronchoscopy</td>
<td>Sjogren et al, 2017</td>
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<td>31.2 mo (average)</td>
<td>Airways</td>
<td>FBs (71% organic)</td>
<td>Complicated with secondary airway infection (44%)</td>
<td>Rigid laryngobronchoscopy</td>
<td>Gruber et al, 2017</td>
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<td>Pediatric patients</td>
<td>Airways</td>
<td>Airway FBs (nuts, beans)</td>
<td>—</td>
<td>Mini grasping basket forceps + ultrathin flexible bronchoscope</td>
<td>Hata et al, 2017</td>
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<tr>
<td>A 13-month-old boy</td>
<td>Trachea</td>
<td>Nuts</td>
<td>Pulmonary edema</td>
<td>Bronchoscopy + intubation</td>
<td>Bashir et al, 2017</td>
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<td>&lt;18 y</td>
<td>Tracheobronchial</td>
<td>FBs</td>
<td>—</td>
<td>NIV + sedation + flexible endoscopy (short length)</td>
<td>Soong et al, 2017</td>
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<tr>
<td>Age</td>
<td>Anatomical Location</td>
<td>Object</td>
<td>Symptoms</td>
<td>Treatment</td>
<td>Reference</td>
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<td>&lt;23 mo</td>
<td>Tracheobronchial tree (62% left bronchial tree and 55% right)</td>
<td>Nuts</td>
<td>—</td>
<td>Endoscopy (under general anesthesia) + the apneic technique</td>
<td>Cohen et al, 1980</td>
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<td>Middle-aged adults</td>
<td>Larynx</td>
<td>Impacted FB</td>
<td>Sudden onset of change in their voice without any respiratory difficulty</td>
<td>Direct laryngoscopy under general anesthesia</td>
<td>Hada et al, 2015</td>
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<td>A 56-year-old man</td>
<td>Larynx</td>
<td>Teeth</td>
<td>Sudden dyspnea owing to a fulminant onset of massive laryngeal swelling</td>
<td>Tracheostomy + direct laryngoscopy under general anesthesia</td>
<td>Droege et al, 2017</td>
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<td>Median, 56.5 y</td>
<td>Larynx</td>
<td>FB airway obstruction</td>
<td>Choking</td>
<td>Heimlich maneuver + abdominal thrusts</td>
<td>Pavitt et al, 2017</td>
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<td>A 44-year-old man</td>
<td>Right main bronchus and the duodenum</td>
<td>Two metallic foreign bodies (a knife blade)</td>
<td>Intermittent cough</td>
<td>Thoracotomy after the failure of endoscopic treatment</td>
<td>Guo et al, 2017</td>
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<td>A 55-year-old man</td>
<td>Right main bronchus</td>
<td>Fractured dental plate</td>
<td>Severe dyspnea and hoarseness</td>
<td>Direct laryngoscopy + computed tomography + rigid bronchoscopy</td>
<td>Evman et al, 2016</td>
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Abbreviations: FB, foreign body; NIV, noninvasive ventilation.
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<tr>
<td>Book</td>
<td>Supraglottis</td>
<td>Malignant tumor, infection, abscess</td>
<td>Increased work of breathing (obstruction) and respiratory distress</td>
<td>Careful assessment of the airway + prompt correction of the causative factor</td>
<td>Sinha et al, 2017</td>
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<tr>
<td>A young man</td>
<td>Supraglottis</td>
<td>Acute epiglottitis + abscess</td>
<td>Odynophagia, dysphonia and dyspnea and rapidly progression of upper airway obstruction</td>
<td>Urgent tracheostomy + direct laryngoscopy + drainage of abscess + IV antibiotics</td>
<td>Vasileiadis et al, 2013</td>
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<td>3 adults</td>
<td>Lower airways</td>
<td>Stage IV - NSCLC</td>
<td>Lung obstruction caused by *tumor-mediated compression + ILD</td>
<td>Aggressive treatments for ILD</td>
<td>Nakahama et al, 2017</td>
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<td>17 patients</td>
<td>Lower airways</td>
<td>Mycoplasma pneumonia (M pneumoniae)-associated bronchiolitis obliterans and mild to severe airway obstruction</td>
<td>Wheezing and dyspnea and fever and cough</td>
<td>HRCT + lung function tests</td>
<td>Zhao et al, 2017</td>
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<td>An adult</td>
<td>Larynx</td>
<td>A laryngeal hemangioma</td>
<td>Near-fatal acute airway obstruction</td>
<td>Transoral (laparoscopic bipolar tissue-sealing device)</td>
<td>Bannon et al, 2017</td>
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<td>102 patients (&lt;10 y) and 57 patients (10–18 y)</td>
<td>Cervical region</td>
<td>ANI: Peritonsillar abscess -retropharyngeal abscesses, Submandibular abscesses</td>
<td>Fever, Odynophagia, Toothache - neck pain, Airway obstruction (2 patients)</td>
<td>IV antibiotics, Drainage of the abscess</td>
<td>Córte et al, 2017</td>
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<tr>
<td>22 patients</td>
<td>Cervical region</td>
<td>HNC</td>
<td>Acute dyspnea (upper airway obstruction)</td>
<td>PIF meter, Tracheostomy, Laryngeal fiberoscopy</td>
<td>Lesnik et al, 2017</td>
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<td>A case</td>
<td>Larynx</td>
<td>Acute Supraglottic and glottic pathology</td>
<td>Complete airway obstruction</td>
<td>THRIVE, Surgical Tracheostomy</td>
<td>Desai et al, 2017</td>
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*ILD: Interstitial lung disease
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<tr>
<th>Age/Gender</th>
<th>Location</th>
<th>Diagnosis</th>
<th>Symptoms</th>
<th>Treatment/Procedure</th>
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<tr>
<td>21 children (3 mo – 12 y)</td>
<td>Neck</td>
<td>RPA; FB ingestion 10%</td>
<td>• Respiratory compromise (29%)</td>
<td>Surgical drainage (transoral 70% and external cervical 20%)</td>
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<tr>
<td>A 60-year-old man</td>
<td>Neck</td>
<td>PPS tumors (<em>pleomorphic adenoma</em>)</td>
<td>• Breathing difficulty and acute stridor &lt;br&gt;• Nonspecific symptoms &lt;br&gt;• An asymptomatic mass &lt;br&gt;• Mild bulging in the soft palate or tonsillar region &lt;br&gt;• Asymptomatic &lt;br&gt;• Acute shortness of breath and stridor</td>
<td>A transcervical approach and Excision</td>
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<td>63-year-old woman</td>
<td>Posterior fossa surgery</td>
<td>Acute postoperative (vestibular schwannoma) submandibular sialadenitis</td>
<td>• Swelling of right submandibular gland (airway obstruction) &lt;br&gt;• Stridor and respiratory distress</td>
<td>Reintubation &lt;br&gt;Antibiotics &lt;br&gt;Steroids &lt;br&gt;Local massage</td>
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<td>A 74-year-old</td>
<td>Oral cavity (an adenocarcinoma of the right palatomaxillary region)</td>
<td>Postoperative airway obstructions – functional (sagging tongue, laryngospasm, or bronchospasm) and pathoanatomical (airway swelling or hematoma within the airways) and FB related</td>
<td>A postoperative airway obstruction owing to a large fragment of the patient’s maxillary bone, left accidentally in situ after transoral surgical tumor resection</td>
<td>Direct visualization (Magill-type forceps) + endotracheal intubation via the nasal route + endoscopy</td>
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**Abbreviations:** ANI, acute neck infections; CT, computed tomography; FB, foreign body; HNC, head and neck cancer; HRCT, high-resolution computed tomography; ILD, interstitial lung disease; IV, intravenous; NSCLC, non–small cell lung cancer; PIF meter, peak inspiratory flow; PPS, primary parapharyngeal space; RPA, retropharyngeal abscess; THRIVE, transnasal humidified rapid-insufflation ventilatory exchange.
Fig. 1) include the extrathoracic and intrathoracic portions of the trachea, the extrapulmonary and intrapulmonary bronchi, and the bronchioles, alveolar ducts, and alveoli, which are intrathoracic and intrapulmonary. The nose and mouth are the 2 parallel pathways by which air enters and leaves the system. The nasal cavity and nasopharynx have a large surface area and tortuous path of airflow that is conducive to filtering, warming, and humidifying ambient air. The nasal cavity has fairly rigid walls, and the main factors that impact resistance to airflow in this region are physical obstructions...
such as polyps, septal deviation, swelling of the mucosa, the and accumulation of secretions in the airway lumen.

With the exception of the pharynx, the walls of the airways become less rigid distally, with the walls of the upper airways containing bone and cartilage, the large lower airways containing cartilage rings or plates, and the small lower airways lacking bone and cartilage. The pharynx (see Fig. 1) is posterior to the turbinates and separated into the nasopharynx, oropharynx, and laryngopharynx. The nasopharynx passes over the soft palate before opening into the oropharynx. The hyoid bone and soft tissue comprising the airway palate before opening into the oropharynx. The hyoid bone and soft tissue comprising the airway in this region are not directly attached to the surrounding skeletal structures, making the wall of the pharynx deformable.2,3

In humans, there is a relatively large distance between the soft palate and epiglottis, and the face is flattened, resulting in a long, narrow oropharynx upon which the tongue encroaches. Another unique feature is that adipose tissue accumulates in the surrounding tissue and can apply pressure to the outside of the airway, affecting lumen diameter. The epiglottis and larynx play major roles in protecting the lower airways. The epiglottis deflects solids and liquids traveling through the oropharynx away from entering the larynx, directing them down the esophagus. The larynx has a high density of receptors for diverse chemical entities that, when stimulated, evoke a cough reflex that expels solids and liquids from the airway.

The trachea, bronchi, and terminal bronchioles are conducting airways that lack alveoli. The trachea extends from the larynx in the cervical region to the carina in the thoracic cavity. Like the larynx, the carina is sensitive to tactile stimulation, which evokes cough. The wall of the trachea is supported by 15 to 20 C-shaped rings of cartilage interspersed with soft tissue. In contrast with the trachea, the bronchial wall is supported by plates of cartilage with a greater degree of deformability than the tracheal rings. The bronchioles lack cartilage and branch into alveolar ducts that terminate in alveolar sacs. Dichotomous branching of the airways leads to an increase in the number of airways in parallel. The diameter of each airway decreases and the total cross-sectional diameter of the airspace increases distally. Only about 2% of the total airway resistance is accounted for by the bronchioles and alveolar ducts.

Airway musculature
Muscles of the upper airways are striated under autonomous, and in some cases, conscious control. Pharyngeal muscles are separated into 4 muscle groups based on the structures they control: the tongue, palate, hyoid bone, and wall of the pharynx.4 The extrinsic muscles of the tongue include the genioglossus, styloglossus, and hyoglossus. The genioglossus pulls the tongue forward and down, keeping the tongue from occluding the oropharynx. The genioglossus exhibits phasic activity during inspiration, tonic activity during expiration, and responds to hypoxia, hypercapnia, and negative pressure in the larynx, indicating that it is controlled at least in part through the respiratory centers in the brain stem.

The palate is controlled by 5 muscles: the tensor palatini, levator palatini, palatoglossus, palatopharyngeus, and muscular uvula. The tensor palatini stiffens the soft palate. The levator palatini and palatoglossus raise and lower the soft palate, respectively, either closing or opening the nasal and oral air passages, respectively. All hyoid muscles manipulate the hyoid bone, moving it anteriorly and caudally, dilating the upper airway. The pharyngeal constrictor muscles assist in swallowing and constrict the airway at normal and elevated lung volumes.1 At the level of the larynx, the muscle in the airway wall transitions to a smooth muscle phenotype. Smooth muscle is found throughout the airways, from the trachea to the alveolar ducts.

Innervation
Upper airways The upper airways are innervated by sensory, motor, parasympathetic, and sympathetic neurons.5,6 The soft palate and walls of the pharynx contain both constrictor and dilator muscles that move contents of the pharynx to the esophagus, close the nasopharynx and larynx during swallowing, and stabilize the airway during normal breathing. The vagus nerve (cranial nerve X) innervates the remaining muscles of the soft palate (levator veli palatine, palatoglossus, palatopharyngeus, musculus uvulae), the major constrictor muscles in the pharyngeal wall (superior, middle, and inferior constrictors), the salpingopharyngeus muscle that draws the larynx upward during swallowing, and the muscle of the larynx.

Lower airways The lungs are innervated by parasympathetic cholinergic and parasympathetic noncholinergic neurons carried in the cranial nerve X, and sympathetic adrenergic and sympathetic nonadrenergic neurons carried in spinal nerves between T1 and T6.7,8 Human airway smooth muscle exhibits little sympathetic innervation.8 The Aδ mechanosensitive fibers can be separated into slowly adapting reflexes (SAR) and rapidly
adapting reflexes (RAR) functional phenotypes, with SARs being associated with regulatory inflation and deflation reflexes (eg, Hering-Breuer) and RARs being polymodal and associated with defensive reflexes such as cough and sneeze.9

**Mechanical, thermal, and chemical receptors** Whereas SARs respond primarily to mechanical deformation, RAR and C-fibers are polymodal, responding to diverse stimuli including temperature, acidity, and osmolarity. From a more fundamental standpoint, they constitute a critical interface between the environment and the lungs.10

**Regulatory reflexes** Maintenance of O2, CO2, and pH levels is a primary function of the respiratory system. During inspiration, negative pressure develops in the airway lumen, acting to collapse the airway and restrict airflow, particularly in the extrathoracic airways that are surrounded by barometric pressure. Reflexes exist to both preempt and respond to collapse of the upper airways. Under normal conditions, hypercapnia and hypoxia are primary stimuli of the respiratory central pattern generator in the brainstem. Of the 3 classes of sensory fibers found in the airways—SAR, RAR, and C-fibers—SAR neurons are most closely associated with regulatory reflexes. Activation leads to tachycardia, relaxation of airway smooth muscle, inhibition of inspiratory drive, and prolongation of expiration.11–13

**Defensive reflexes** Defensive reflexes mediate changes in mucociliary clearance, sneezing, and coughing to actively clear inhaled agents from the airways. Compared with SAR fibers involved in regulatory reflexes, RAR neurons and C-fibers exhibit greater sensitivity to tactile stimulation, pH, and chemical agents and play major roles in defensive reflexes. RAR neurons respond to mechanical deformation, but also to inhaled irritants (eg, smoke, ammonia,11 and low osmolarity solutions12,13). Response of the RAR irritant receptors is associated with cough, bronchoconstriction, and mucus secretion.13 C-fiber activation is associated with cough, rapid shallow breathing, apnea, bronchoconstriction, mucus secretion, bradycardia, and hypotension.11–13

The outputs from the nucleus of the solitary tract converge on brainstem and spinal neurons, controlling ventilation, cardiac function, airway diameter, salivary and mucus gland secretion, and pain, leading to significant overlap in efferent responses to SAR, RAR, and C-fiber activation.11 There is clear evidence of reflex involvement in sneezing, nasal secretion, and congestion.5 Coughing is induced by irritants or tactile stimulation of the nasal mucosa, but also exposure of the eyes to bright light or exposure of areas of the skin to sudden changes in temperature will induce sneezing. Cough is both a protective mechanism for clearing pathogens, chemicals, and debris from the airways and a chronic, often debilitating, manifestation of infection and inflammation. Interestingly, the cough reflex is lost after denervation of the lower airways during lung transplant surgery, but is then partially restored in some cases.14

The cough reflex can be initiated via mechanical or chemical stimuli through parallel vagal afferent pathways. Bronchopulmonary C-fibers terminate in the mucosa, submucosa, parenchyma, and vasculature from the larynx to the peripheral lung.15 Cough can also be initiated by receptors in the larynx, trachea, and large bronchi that activate Aδ fibers.16 In addition to cough, irritation in the upper airways can induce apnea, bradycardia, and changes in peripheral vascular resistance.17

An aspiration reflex is associated with mechanical stimulation of the nose, nasopharynx, and oropharynx. The reflex facilitates clearance of inhaled particles to the esophagus and can be mimicked by stimulation of the glossopharyngeal nerve. Similar to the nose and pharynx, the larynx also exhibits a high density of mechanical, irritant, and chemical receptors. When stimulated, these receptors induce apnea, hypertension, bradycardia, bronchoconstriction, and cough.17

**Mucociliary clearance** Particles depositing on the airway surface become entrapped in mucus gel layer (7–70 μm thick) floating on the airway epithelium.18,19

**Airway resistance** The nose accounts for approximately 50% of the total resistance to airflow in the airways. The configuration of the respiratory system leads to region-specific closure of airways during inspiration and expiration. Respiratory muscles act on the chest wall and diaphragm to change the pressure in the pleural space and alveoli, which subsequently drive airflow. The nasal resistance lowers the pressure in the pharynx during inspiration, predisposing the pharynx to collapse during inspiration.20 In contrast, the restriction opposes collapse of the distal airways during exhalation by providing a backpressure in the airway lumen.21

**DISCUSSION**

There are a large number of causes of airway obstruction (see Tables 1 and 2). Airway
obstruction may occur at any point from the mouth down to the trachea and bronchial tree. The commonest site for obstruction in the obtunded unconscious patient is at the pharynx, because the tongue falls back against the posterior pharyngeal wall, and a lack of muscle tone causes narrowing of the airway diameter.

Patients with a reduced level of consciousness are unable to clear their own secretions and cannot protect their own airway. A Glasgow Coma Scale of 8 of 15 or less is often considered the threshold at which intubation is necessary. In practice, a more focused approach is taken when deciding to intubate patients, bearing in mind factors such as the potential for further deterioration and moving from a place of safety to one of greater isolation (eg, transfer from resuscitation department to the radiology department).

Also, think about patients in whom surgery, trauma, or burns may contribute to airway compromise, for example, from hematoma and edema. Because these situations are dynamic and may rapidly progress from one of stability to one of a threatened and compromised airway, early intubation is undertaken in these risk groups.

External compression from an adjacent pathology, for example, goiter, lymphadenopathy, tumor, or hematoma (eg, after thyroidectomy) may be insidious or rapid in onset. In patients with underlying malignancy, it is important for clinicians to be vigilant in identifying features suggestive of airway compromise. The soft tissues in the pharynx and larynx are vulnerable to swelling and edema if traumatized, or at the site of infection.

Postextubation laryngeal edema may be seen after traumatic and multiple attempts at intubation, and in patients receiving prolonged periods of intubation where high cuff pressures may cause edema of laryngeal mucosa. Local trauma after foreign body (FB) ingestion, for example, a fish bone embedded in soft pharyngeal tissues, can cause significant airway compromise and in some cases the development of pharyngeal abscess.

In children, whose airways are relatively smaller, mucosal swelling, upper respiratory obstruction, and stridor may be associated with infections such as laryngotracheobronchitis (croup) and epiglottitis. Upper airway stimulation in the presence of secretions or inhalation of foreign material may cause laryngeal spasm with adduction of the vocal cords, preventing passage of air to the lungs and leading to the development of hypoxemia.

When assessing patients, look carefully for signs and symptoms (snoring, stridor, expiratory wheeze, gurgling, reduced conscious level, etc) and always call for help early from an anesthetist if you suspect airway compromise.

The young can compensate well initially, masking impending desaturation, and hypoxemia. Be mindful of the types of injuries that compromise the airway, such as facial burns, bleeding, and foreign bodies obstructing the airway. Always provide high flow oxygen with a reservoir bag at 15 L/min, and reassess frequently, looking for signs of deterioration. The recovery (lateral) position pushes the tongue and jaw forward under gravity, improving the airway. A secure airway is one in which the trachea and bronchial tree are protected from aspiration of gastric contents or secretions by the presence of a cuffed endotracheal tube (or a tracheostomy).

Herein, the causes of airway obstructions are analyzed and discussed thoroughly in the light of recent literature.

**AIRWAY FOREIGN BODIES AND TUMOR- AND INFECTION-RELATED AIRWAY OBSTRUCTIONS**

FB aspiration in the airway of children is a life-threatening clinical situation responsible for many deaths each year. The study reported that 60% of patients were under 3 years of age. The time interval between aspiration of FB and onset of diagnosis ranged from 2 hours to 5 months. The most frequently detected FBs are toys, sweets, batteries, jewels, rocks, and magnets. The laryngotracheobronchial FBs require early diagnosis and management to decrease the incidence of complications and make removal of aspirated FB easier. Impacted penetrating FB (a metal rod, a pencil, etc) in the airway especially the postnasal space presents with management challenges and necessitates intubation and tracheostomy. Careful anticipation and quick intervention are helpful.

A multicenter, retrospective review of children undergoing bronchoscopy for FB removal showed that bronchoscopy for identification and removal of airway foreign bodies had minimal morbidity in this group. In another study of complicated airway FB extraction, it was concluded that unwitnessed aspiration events and abnormalities on chest radiograph might be associated with a more complicated course in children with FB aspiration. Inhaled foreign bodies in children are common and may be complicated by secondary airway tract infection. Antibacterial treatment might be considered in some of these cases. A case with polycarbophil calcium lodged in the bronchus was reported from Japan by Enokido and colleagues.
Appropriate device selection is crucial for endobronchial FB removal using a bronchoscope. Owing to the narrow access to the airway, use of a mini grasping basket forceps in combination with an ultrathin flexible bronchoscope was useful for removing smooth, soft materials such as a nuts or beans in pediatric cases.\textsuperscript{27} Using short-length flexible endoscopy with a noninvasive ventilation technique, appropriate sedation, and intensive care support is a safe, simple, and effective modality for the retrieval of tracheobronchial foreign bodies immediately after confirming the diagnosis in pediatric patients.\textsuperscript{28}

Mendsaikhan et al\textsuperscript{29} reported the management of potentially life-threatening emergencies at 74 primary level hospitals in Mongolia. FB removal was performed at a rate of 86.5% and airway management 13.5% in the study population.\textsuperscript{29}

Postoperative airway obstructions may be classified as functional (sagging tongue, laryngospasm, or bronchospasm), pathoanatomical (airway swelling or hematoma within the airways), or FB related. Schober et al\textsuperscript{30} reported a patient with postoperative airway obstruction owing to a large fragment of the patient’s maxillary bone, left accidentally in situ after transoral surgical tumor resection.

Organic material (eg, nuts in children and bones or food in adults) is the most common FB inhaled by patients. Just one-tenth of all foreign bodies in the airway are located in the larynx.\textsuperscript{31} Laryngeal foreign bodies among adults are rarely seen but can be a life-threatening event requiring immediate lifesaving intervention.\textsuperscript{32,33} Even small foreign bodies measuring just 1 mm $\times$ 3 mm can cause a massive laryngeal edema demanding skilled medical staff to rescue the patient’s life, namely, tracheostomy and direct laryngoscopy.\textsuperscript{34}

FBs removed by a bystander at the accident scene lead to a significantly high rate of favorable outcomes versus those removed by emergency medical technicians or emergency physician at the scene (73.7% vs 31.8%; $P$.0075) and at the hospital after transfer (73.7% vs 9.6%; $P$.0001).\textsuperscript{35}

Significant predictors of FB aspiration include abnormal physical and radiologic findings; choking; noisy breathing; stridor; dysphonia; new-onset, recurrent, or persistent wheezing; and unilateral reduced air entry. A high index of suspicion is required in diagnosing airway FB.\textsuperscript{36} The Heimlich maneuver is a well-known intervention for the management of choking owing to FB airway occlusion. Self-administered abdominal chair thrusts produced similar pressures to those performed by another person. Both approaches should be included in basic life support teaching.\textsuperscript{37}

The public health and economic burden of pediatric airway foreign bodies seems to be increasing, especially in urban locations and teaching hospitals.\textsuperscript{38} Foreign bodies in the airway, as well as those in the upper gastrointestinal tract, are life-threatening conditions and require urgent intervention. Guo et al from China, reported a male patient who presented with 4 days of intermittent cough.\textsuperscript{39} A computed tomography scan showed 2 metallic foreign bodies located in the right main bronchus and the duodenum that were retrieved via upper gastrointestinal endoscopy and a thoracotomy.\textsuperscript{39}

Evman et al\textsuperscript{40} reported a man who presented with severe dyspnea and hoarseness, starting immediately after a hypotensive syncope attack at home. The patient had generalized stridor and right-sided wheezing, with no finding in the upper airway on direct laryngoscopy. Chest radiographs and computed tomography of the thorax revealed a hyperopaque FB over the carina that was successfully removed by rigid bronchoscopy (a fractured dental plate).\textsuperscript{40} Postobstructive pulmonary edema is thought to occur from hemodynamic changes secondary to forced inspiration against the closed airway owing to acute or chronic airway obstruction.\textsuperscript{41}

**TUMOR- AND INFECTION-RELATED CAUSES FOR AIRWAY OBSTRUCTION**

Supraglottic obstruction\textsuperscript{12} is reported to be a medical or surgical emergency. It can lead to increased work of breathing and respiratory distress, and lead to fatal cardiopulmonary arrest. Supraglottic obstruction can be acute or chronic and can present as partial obstruction or complete obstruction. Careful assessment of the airway is important, keeping in mind not to agitate or aggravate the child’s distress and anxiety, which can, in turn, worsen respiratory distress (narrow calibers, the position of the larynx, a large tongue, and the poor tone of the pediatric patient).

The life-saving treatment urgent algorithm should be as follows:

- Rapid recognition,
- Prompt correction, and
- Intervention to relieve airway obstruction.

Acute epiglottitis is an acute inflammation in the supraglottic region of the oropharynx, which is a potentially life-threatening condition leading to rapid upper airway obstruction. An uncommon consequence of acute epiglottitis is the epiglottic abscess, which provokes odynophagia, dysphonia, and dyspnea, with rapid progression of upper airway obstruction. A fiberoptic
nasopharyngolaryngoscope in the emergency department can reveal an epiglottic abscess. Aggressive airway management, surgical drainage of the abscess, and intravenous antibiotics are the hallmarks of treatment.

Nakahama and colleagues reported that 3 patients with stage IV non–small cell lung cancer with signs of lung obstruction (tumor-mediated compression) developed acute interstitial lung disease within 10 days of commencing nivolumab treatment. Obstructive findings in the lungs, which readily cause infections, may be an important risk factor for nivolumab-induced interstitial lung disease. Mycoplasma pneumoniae-associated acute bronchiolitis might precede the development of bronchiolitis obliterans. Patients present with wheezing and/or dyspnea at the time of diagnosis of bronchiolitis obliterans. Another report describes a case of near-fatal acute airway obstruction secondary to a laryngeal hemangioma that was treated by a surgical resection using a laparoscopic bipolar tissue-sealing device.

The most frequent acute neck infection was peritonsillar abscess. Most retropharyngeal abscesses occurred in children, and submandibular abscesses in adolescents. The most common symptoms/signs were fever and odynophagia. All patients received intravenous antibiotics and 86.8% underwent drainage of the abscess. The younger age, presence of multiple abscesses, or a palpable cervical mass on admission were associated with prolonged hospitalization.

The role of peak inspiratory flow is assessed as a standardized noninvasive tool in quantifying severe inspiratory dyspnea requiring emergency tracheostomy, especially in head and neck cancer. Peak inspiratory flow values of less than 53.1 L/min (ie, 18.3% of theoretic value) correlated with the need for emergency tracheotomy.

Desai and Fowler reported a new airway technique that uses high-flow humidified nasal oxygen, which can extend apnea time and maintain oxygen saturation for emergent surgical tracheostomy transnasal humidified rapid-insufflation ventilatory exchange. The patient needed emergent tracheostomy because of a compromised airway secondary to acute supraglottic and glottic pathology. Transnasal humidified rapid-insufflation ventilatory exchange maintained the oxygen saturation for 40 minutes until transient desaturation developed after complete airway obstruction.

A retropharyngeal abscess is a potentially serious deep neck space infection occurring more frequently in children than in adults. Prompt diagnosis of retropharyngeal abscess, especially in infants, is mandatory to prevent potentially fatal complications, including airway obstruction and mediastinitis.

Primary parapharyngeal space tumors are rare, representing only 0.5% of all head and neck neoplasms (80% are benign [pleomorphic adenoma]). It presents as an asymptomatic mass causing mild bulging in the soft palate or tonsillar region, or fullness near the angle of the mandible in the neck. The tumor should be excised via a transcervical approach before it causes life-threatening upper airway obstruction and acute respiratory failure.

A patient with a left-sided vestibular schwannoma who developed airway obstruction in the postoperative period owing to swelling of right submandibular gland (acute postoperative sialadenitis owing to an extreme degree of rotation and flexion of the head during surgery) was reported. The authors suggested that the conservative approach would do well for such cases.

Respiratory dysfunction has been associated with Parkinson’s disease. The respiratory symptoms vary greatly. Most patients remain asymptomatic, whereas others present with acute shortness of breath and even stridor. Respiratory dysfunction is due to a combination of factors, including restrictive changes, upper airway obstruction, abnormal ventilatory drive, and response to medications (levodopa).

High-flow nasal cannulae deliver high flows of blended humidified air and oxygen via wide-bore nasal cannulae and may be useful in providing respiratory support for adult patients experiencing acute respiratory failure in the intensive care unit. For the primary outcomes of treatment failure and mortality investigators found no differences between high-flow nasal cannulae and low-flow oxygen therapies. Improvement in respiratory rates when high-flow nasal cannulae was compared with continuous positive airway pressure or bilevel positive airway pressure was not clinically important.

**SUMMARY**

The literature cited in this article related to the causes and management options for relieving the urgent airway obstructions are summarized in Tables 1 and 2. It is important to assess airway patency in any patient at risk of airway obstruction. This forms part of the ABC approach, sequentially assessing airway, breathing, and circulation as described by Nolan and colleagues in life support algorithms. Recognizing and acting on airway compromise decreases morbidity and mortality in patients. Pulse oximetry is a poor indicator of airway compromise and decreasing arterial hemoglobin oxygen saturation reflects depleted stores.
of oxygen in the lungs and is a late sign of impending hypoxaemia.

Basic airway maneuvers (with supplementary oxygen) will often improve the patency of an obstructed airway. Getting help from an anesthetist early is a priority. Before definitive control of the airway is possible, provide 100% oxygen with a tightly fitting mask to optimize body oxygen stores.

Principles of urgent management (algorithmic steps) are summarized as follows.

**MAIN emergency airway management**

- Immediate quick evaluation of the patient (consciousness, breathing, choking, stridor, cyanosis, bleeding, etc).
- Needs intubation.
  - If intubation is successful, then postintubation management.
  - If unresponsive, then maintain oxygenation.
- If intubation is unsuccessful and failed oxygenation, then
  - Predict difficult airway!
  - Try cricothyrotomy.
- If the cricothyrotomy is contraindicated, then
  - Choose one of
    - Flexible or rigid endoscopy,
    - Video/direct laryngoscopy, or
    - Attempt at tracheal intubation (be ready for a surgical airway simultaneously!).
- Place cuffed endotracheal tube (in children <8 years of age, an uncuffed or cuffed endotracheal tube may be placed. In neonates, uncuffed endotracheal tubes should be placed).
  - If successful, then postintubation management.
  - If unsuccessful, then arrange for definitive airway management.

Airway management should progress rapidly from the least to the most invasive procedures and devices. Unconscious patients lack the muscular tone and control to maintain a patent airway. For this reason, an airway must be established and maintained in the initial assessment of all unconscious patients. Spinal precautions should be considered in all trauma patients who need airway management or ventilator support until a radiograph of the spine has been taken. The features of airway obstruction should be recognized early, identified and treated immediately to secure the airways. Keep in mind that oxygenation is of paramount importance. Try vigorously to provide a high oxygen concentration to patients in whom airway compromise is suspected. Keep in mind the dangerous sequelae of hypoxia and aspiration. Calling for immediate expert help from an anesthetist will help reduce these risks. The principal steps for managing an urgent airway obstruction given in this article should be kept in mind and analyzed thoroughly to save lives and prevent complications owing to airway obstruction.

**REFERENCES**

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