Abstract

Objective: to review the main publications on foreign body aspiration.

Sources: a bibliographic search was carried out in Medline (1966-2000) and Lilacs (1979-1999), in Portuguese, Spanish and English, using the keywords “aspiration, foreign body, children, adolescents”.

Synthesis of data: the universal distribution of these accidents was confirmed. This condition is predominant in males (51.0-73.0% of the cases) and in children aged under 3 years (65.8-85.0% of the accidents). By analyzing clinical history and physical examination together, we found a sensitivity and specificity of approximately 80% and 40%, respectively. The radiological examination was very useful for diagnosis, showing a sensitivity between 57.9% and 100%. Nuts are the most common inhaled objects, amounting to approximately 70% of the episodes.

Conclusions: rigid bronchoscopy is the procedure of choice and requires specialized professional training and well-equipped services. However, the preventive aspects of these accidents were not sufficiently emphasized in the context of this condition. This review has a specific section on these aspects.


Historical aspects

The first report of the removal of an airway foreign body by bronchoscopy dates back to 1897. The procedure was carried out by Gustav Killian, a doctor who was part of the clinical staff of the University of Friburg in Brisgau, Germany. Killian started his career as a specialist in ear, nose, and throat diseases; little by little, however, the good doctor started dedicating himself exclusively to laryngology.

Within a short period of time, the name of Killian gained international notoriety. In the following year, Killian published the first results of his groundbreaking studies on bronchoscopy, an area which, up until that time, had not been widely studied. He designed and built a very simple device using a tube which, when introduced into the airways, allowed visualization and anatomic location of the airway foreign body. Once located, the foreign body could be retrieved using another instrument, which resembled a pair of tweezers (also designed by Killian). Killian became well-known beyond Germany in other European countries and even in other continents. Several patients who were, up until then, helpless, sought treatment with Killian. Patients were referred to the doctor by his peers, who had run out of options for treatment.
One of the first children treated by Killian, and who was considered his first great challenge, was Corina. The patient resided in the city of Montevideo, Uruguay and had aspirated a small metallic whistle which was lodged in the right lung. After two unsuccessful attempts, Killian designed a new instrument, which had three graspers that allowed for removal of the foreign body.2

In 1898, Colidge carried out the first bronchoscopy in the United States by successfully retrieving a fragment from a tracheostomy cannula from the bronchial tree of a 23-year old patient. One of the great advancements in the area came with research and development of new light sources. Max Einhorn, in this sense, devised an internal light source which improved visualization during endoscopy significantly. Subsequently, the bronchoscopy techniques and the instruments used in this procedure were modified and improved. This occurred especially in the United States, by one Chevalier Jackson. Jackson was responsible for the most significant improvements in the basic principles of endoscopic diagnosis and therapeutics, and for the advancement of the preventive approach to accidents with foreign bodies (especially in the case of children) by suggesting the participation of public healthcare services. Other important technological advancements such as image enhancement and use of fiber optics as a light source, both by Edwin Broyles in 1940 and 1962, respectively, also helped to improve image quality.

Later improvements came in 1976 with the use of the Hopkins telescope, which allowed direct visualization of the airways by the endoscopist throughout the procedure. Before the Hopkins telescope, foreign bodies used to be removed blind, since doctors could rely only on their tactile sense for retrieval of the body.3-5

The techniques described by Jackson in 1905, Jackson and Jackson in 1936, and Holinger and Johnston in 1954 are the same techniques applied to date. Despite the fact that today’s professionals can rely on modern instruments and new anesthetic drugs (more efficient and with less adverse effects), the difficulty still lies in teaching doctors how to introduce a rigid tube into the delicate airways of children without causing complications, which, in turn, may be fatal.4-6

Epidemiological aspects

The concern with accidents involving foreign bodies is found in the literature with medical publications that date back to the last century. In 1936, for example, Chevalier Jackson had already reviewed 3,000 cases of accidents of ingestion and aspiration of foreign bodies and enumerated their main causes.4

Most victims of foreign body aspiration are infants and children in their first years of life. The several studies published in the past decade show that children aged less than five years represented 84% of cases of aspiration of foreign bodies; what is more, most cases (73%) were of children in the first three years of life. There is a prevalence of accidents in the male sex, for a 2:1 ratio in the comparison of accidents in boys to those in girls.6-8

Differences in the distribution according to sex and age group and in the therapeutic modalities are not significant as related to different countries; the type of foreign body aspirated, however, is related to the local eating habits. In the United States and Europe, there is a prevalence of aspiration of peanuts; in Egypt, of watermelon seeds; in Turkey, of sunflower seeds; and in Greece, of pumpkin seeds.9

Before the introduction of the technique described by Chevalier Jackson, in 1905, the mortality rate of procedures of foreign body retrieval was as high as 50%; currently, it is lower than 1%.10,11 In Brazil, the magnitude of mortality is still unknown; in the United States, in turn, there are around 500 to 2,000 deaths per year.12 In this sense, in 1984 the National Safety Council described foreign body aspiration as the forth most important cause of accidental deaths in children of all ages, and the third in children aged less than one year.9

Though the relation of foreign body aspiration with social and economical aspects is still not widely studied, and though this relation requires further elucidation, it is, however, reported as a risk factor for foreign body ingestion or aspiration. In 1997, Arjmand et al.13 found that fifty percent of all children in the US who were victims of foreign body ingestion were uninsured. Also, in most aspiration events, the child was being fed the inappropriate food item according to his or her age, perhaps indicating a lack of caretaker education and anticipatory guidance.13 According to the study protocols in the international literature, there are no studies in Brazil that have clearly assessed the influence of social and economical status as a risk factor for foreign body ingestion or aspiration by children.14-17

In the United States, in 1973, the Consumer Product Safety Commission created the National Electronic Injury Surveillance System which, at the time, monitored 119 hospitals in all geographical regions of the country. From 1988 to 1990, there were 41 cases of death in children whose age average was 14.8 months; the data also indicated that deaths were mostly of boys (61% of cases). The most dramatic finding was that 97% of deaths occurred at home. Race was not considered a risk factor and social and economic conditions were not assessed.18

Clinical aspects

The classical manifestation of foreign body aspiration is paroxysmal cough, a natural defense mechanism to drive out the aspirated object. Depending on the age of the patient, on the type of foreign body aspirated, and on where
the body is anatomically located in the airways there may be total or partial obstruction of the passage of air. After the initial manifestations, the aspiration may become oligosymptomatic or even asymptomatic for hours, days, or even weeks until the reappearance of symptoms.9

A foreign body in the larynx can cause total obstruction of the respiratory tract and, consequently, it may cause the death of pediatric patients, as reported in 45% of cases.9 In cases of partial obstruction, there may be symptoms of crackles, hoarseness, loss of voice, odynophagia, hemoptysis, and dyspnea of different severities; objects can remain impacted for prolonged periods of time.

Lodging of a foreign body in the trachea may also be potentially fatal, especially in children aged less than one year; this depends, clearly, on the severity of the obstruction. It is possible to auscultate the impact of the object against the wall of the subglottic region and the main carina; it is also possible to sense the impaction of the object by palpation of the chest. Diffuse wheezing can be verified in most cases.6

Impaction of the foreign in the bronchial tree usually yields symptoms of cough and wheezing, frequently unilateral, and of respiratory noises, dyspnea of variable severity, and cyanosis.6

The diversity of clinical manifestations is also related to the organic or inorganic nature of the aspirated foreign body. Since organic objects frequently unleash inflammatory reactions, this may worsen the obstruction of the Airways and thus shorten the duration of the asymptomatic period. Losek, in 1990, reported that 40% of patients with aspiration of an inorganic foreign body had normal physical examinations, whereas only 13% of those with aspiration of organic foreign body had normal examinations. What is more, the author also observed that 57% of patients were asymptomatic at presentation and 19% had normal physical examinations.19

The interval of time between beginning of symptoms and correct diagnosis was studied by Wiseman who, arbitrarily, established early diagnosis within 24 hours following the onset of symptoms; the author reported that 46% of the 157 children studied were diagnosed early. Out of the remaining 54%, most were diagnosed at the end of the first week following onset of symptoms, 24% at the end of the first months, and the remaining 16% after one month (up to six years).20

Other authors also studied the interval from the accident to diagnosis of aspiration. Hughes et al. studied, in separate, a group of 83 patients to verify the time from onset of symptoms to admission of the patient for bronchoscopy. In six patients (7%), the time from onset to admission was up to six hours; in 34 (41%), between six and 24 hours; in 16 (19%), between 24 and 72 hours; and in the remaining 27 (33%), over 72 hours. Despite the fact that the authors studied the time to diagnosis of aspiration of a foreign body, they did not mention if the longer time to diagnosis was associated with the severity and the prevalence of complications.21

In Brazil, these complications were studied by Lima et al.22 in a population of 44 children with clinical status suggestive of foreign body aspiration, which was later confirmed by bronchoscopy. The authors carried out lung perfusion scintigraphy 30 days after retrieval of the foreign body in 24 (55%) patients; 16 of these patients presented reduction of lung perfusion. Lima et al. also observed that 78% of patients whose diagnosis was confirmed seven days after the aspiration accident presented perfusion abnormalities, whereas only 25% of patients whose diagnosis was confirmed less than seven days after the aspiration presented such abnormalities; these results indicated a 3.8-fold higher risk for bronchial sequelae in the earlier.22

Hoeve et al., in 1992, studied foreign body aspiration in children as related to the diagnostic value (sensitivity and specificity) of the clinical status of patients. The authors showed, for example, that the sensitivity of the symptom of choking was fairly high (81%), but the specificity was poor (33%).23 Agarwal et al., in turn, showed that complaints suggestive of aspiration at physical examination had 90% sensitivity; the specificity, however, was not reported.24 Moreover, the same authors studied two groups of patients, one in which foreign bodies were identified, and the other in which no foreign body was found. Agarwal et al. observed that there was no single sign or symptom capable of reliably identifying the presence of an airway foreign body.24 In this second analysis, cough and abnormalities on auscultation of the lung indicated, both, 78% sensitivity and, respectively, 37% and 50% specificity. Thus, in cases of suspected foreign body aspiration, bronchoscopy is the diagnostic tool of better value.23

Cases of viral laryngitis are frequent in the age group of patients most susceptible to foreign body aspiration, more specifically, of those aged less than three years. In cases of persistence of hoarseness and/or stridor for several days, or in cases of recurring symptoms which are characteristic of these disorders, the lodging of a foreign body in the larynx should be suspected. When the foreign body is lodged in the trachea, patients may present normal radiological examinations and diffuse respiratory noises; these cases are frequently confounded with asthma attacks. If patients do not respond to the appropriate treatment of an asthma attack, the healthcare professional should consider submitting them to bronchoscopy.

Foreign body aspiration should also be included in the differential diagnosis for chronic or repeated lung diseases, even if the patient has no history that suggests aspiration. At times, foreign body aspiration is suspected only when chest CT scan results are compatible with bronchiectasis.5,6,9,10
Radiological aspects

Though radiological examinations should be carried out in almost all cases, we underscore, once again, that the decision for endoscopic intervention is usually based on a suspicious history and physical examination.25

The literature shows that abnormalities are present in most radiological examinations using simple postero-anterior and profile chest X-rays, with or without forced inspiratory and expiratory techniques.10,14,17,20,24,26 Forced expiratory technique or lateral decubitus body positioning according to the affected side of the lung may allow for better evidence of one of the most frequent abnormalities, namely, overinflation of the affected lung.

Cataneo et al.17 in a study with 74 patients, reported atelectasis as the most frequent radiological finding (41.9%), followed by normal radiography, overinflation (18.9%), and radiopaque foreign body (16.2%). Agarwal et al. obtained slightly different results in their population of 76 children.24 The latter authors identified overinflation as the main radiological alteration (39.5%), which was followed by atelectasis (36.8%), normal radiography (19.7%), consolidation (17.0%), and radiopaque foreign body (5.2%).

Wiseman,20 on the other hand, aimed to differentiate between the clinical features of patients diagnosed early (within 24 hours) and late (beyond 24 hours) following the onset of symptoms. The author submitted patients to simple chest X-ray, inspiratory and expiratory radiography, and fluoroscopy. Results indicated significant differences between the groups. Radiological findings were normal in one third of the patients diagnosed early, overinflation was diagnosed in one half of those patients, and atelectasis or consolidation were diagnosed in one sixth of those patients. In patients diagnosed late, radiological findings were normal in only 9%, and atelectasis or consolidation were diagnosed in one half of this group.

The prevalence of aspirated foreign bodies that are radiotransparent indicates that indirect radiological findings should be carefully considered. Some of the most frequent findings are overinflation, atelectasis, lung infiltrates, and consolidation. These abnormalities are usually local and vary according to time since lodging of the foreign body, to nature of the foreign body, and to the severity of the obstruction.

Chatterji and Chatterji, in 1972, described some of the types of bronchial obstruction as related to the radiological findings of aspirated foreign bodies.27 Partial valve obstruction affecting both the inspiration and expiration of patients with normal radiological examination was reported in 20% of children with bronchial foreign bodies and in half of those with tracheal foreign bodies. Cases of more severe valve obstruction, in which the patient can inhale but not exhale, may result in overinflation. The asymmetry in pulmonary volumes occurs during expiration and patients can present shift of the mediastinal structures toward the affected side. If the foreign body is impacted in the inspiration, blocking the entrance of air, atelectasis and lung collapse can be observed depending of the part of the lung affected. In such cases, pulmonary asymmetry is better visualized during inspiration and shift of the mediastinal structures toward the affected side may be observed. Finally, it may also be observed when the obstruction of airflow results in consolidation of the segment or lobe involved.

Despite the fact that it contributes to an increase the sensitivity of radiological exams, the forced expiration technique is not carried out as part of the routine of most services in Brazil. It should, in this sense, be applied even in patients aged less than three years - which is the age group most frequently affected in cases of foreign body aspiration. At times, this maneuver may be facilitated by fluoroscopy, which increases the suspicion of diagnosis but with elevated exposure to ionizing radiation.28 In the case of tracheal foreign bodies, radioscopy may show abnormalities in 92% of patients, whereas simple chest X-rays identify these abnormalities in 58% of patients.6 However, normal radiological studies may show abnormalities in six to 80% of patients; this corroborates the use of bronchoscopy in cases of suspicious history and physical examination, considering that complications caused by radiopaque foreign bodies vary greatly according to the social and cultural characteristics of each country.10,14,23,24,26,29

Therapeutic aspects

When faced with suspicious clinical or radiological findings or with confirmed foreign body aspiration, the physician and, subsequently, the endoscopist are both responsible for carrying out the differential diagnosis for other pathologies, for confirming the lodging of the aspirated foreign body, and removing the foreign body.

Though endoscopy should be carried out as soon as possible, if it is not carefully prepared or if it is inappropriately hastened, the procedure may result in total respiratory obstruction, impossibility to ventilate, and, consequently, death.9 Conversely, bronchoscopy will always be a safe procedure when carried out by properly trained professionals and a multidisciplinary team including the endoscopist, the anesthesiologist, and the nursing staff; these professionals should also have access to all the appropriate equipment for pediatric patients of all ages, including the graspers for all different sorts of foreign bodies.

Clearing the bronchial obstruction may not result in the immediate ventilation of a specific area of the lung, since there may still be parenchymatous alterations and, consequently, immediate recovery of ventilation and oxygenation should not be expected after retrieval of the foreign body. An attempt to achieve optimal oxygenation may lead to barotrauma which, in turn, may lead to aggravation of hypoxemia. If the foreign body shifts during
Foreign body aspiration - Bittencourt PFS et alii

anesthesia due to coughing or positive pressure ventilation, the patient will present hypoxia. All equipment should be readily at hand before the administration of any anesthetic, and the endoscopist should be prepared to immediately take control of the ventilation of the patient.

Selection of the appropriate equipment for removal of the foreign body depends on the characteristics of each patient and the anatomic location of the foreign body. Most authors indicate the use of telescope-guided bronchoscopy.6,9 This procedure allows direct access to the airways, excellent visualization, continuous administration of oxygen and anesthetic agent, and passage of graspers for the retrieval of the foreign body. Bronchoscope size should be selected according to the age of the child. Aspiration catheters, either rigid or flexible, are important for the removal of secretions yielding better visualization of the foreign body. The choice of grasper depends on the nature of the foreign body to be removed. The use of other instruments, such as Fogarty catheters, is also recommended by certain authors, since they allow for the retrieval of friable objects such as peanuts.3

Currently, the known safety and effectiveness of bronchoscopy do away with the need for finding alternative therapeutic modalities. Wood and Gauderer, in 1984, and Martinot, in 1997, aimed to show the diagnostic value of flexible fiberoptic bronchoscopy in children with suspected foreign body aspiration. The studies showed that flexible bronchoscopy can be indicated in pediatric patients with insufficient evidence to warrant open tube bronchoscopy; in other words, excepting cases of asphyxiating foreign body aspiration, of radiopaque foreign body, and of associated unilaterally decreased breath sounds combined with radiological alterations indicating overinflation. Flexible bronchoscopy is a more cost-effective procedure and offers the advantage of not requiring general anesthesia. In case foreign bodies are detected, the child should be immediately submitted to rigid bronchoscopy.30-32

Law and Kosloske, in 1976, suggested the use of inhalation-postural drainage technique for the removal of aspirated foreign bodies. Children were submitted to micronebulization with bronchiodilators and, next, positioned for postural drainage depending on the anatomic location of the foreign body. Manual percussion was performed every five to ten minutes. Oxygen was not routinely administered during the treatment and total duration of the treatment varied from one to six hours, according to the specific orientation of the doctor. All patients were admitted to pediatric intensive care units, and treatment was reported successful in 25% of selected patients. Though there were no deaths, complications, including cardiorespiratory failure, were observed in 17% of patients who, in turn, responded to resuscitation.33

Despite the advancement in equipment technology, there are still complications associated with the aspiration of foreign bodies in children. Inglis and Wagner studied the complications associated with foreign bodies during a 20-year period, separating patients into two groups: before and after Hopkins telescope-guided bronchoscopy was available. Complications were classified into major, patients who required hospitalization longer than one week after bronchoscopy or open surgery, and minor, patients who presented atelectasis, wheezing, and stridor after procedures that required hospitalization longer than 24 hours. The authors verified a higher incidence of complications related to the longer period since aspiration of the object, to the increase in loss of the foreign body during bronchoscopy guided by the naked eye, and to the greater number of thoracotomies (3:1) for retrieval of the foreign body prior to use of the Hopkins telescope.12

Anesthesia

In children with respiratory difficulties due to an airway foreign body, aspiration of food residue and gastric secretion during anesthesia can be fatal; in this sense, it is imperative to carry out bronchoscopy in fasting patients (which varies according to food and to age of the child). In specific situations of severe respiratory failure and hypoxemia, bronchoscopy should be performed even in the presence of food in the stomach.34,35

Electrocardiograph, pulse oxymetry, and stethoscope monitoring of the patient are mandatory, as well as the use of a venous catheter. Mutual cooperation between the endoscopist, the anesthesiologist, and the nursing team allows for the mutual trust necessary for the success of the procedure. Anesthetic induction is performed with inhaled anesthetics using a face mask; the anesthetics (halothane, isoflurane, and, more recently, sevoflurane) are administered until the patient reaches the adequate level of anesthesia for endoscopic surgery. The patient should remain with spontaneous breathing.

Before the bronchoscope is introduced, the patient should be prepared with topical anesthesia of the larynx and trachea by direct instillation of lidocaine at 2% using the laryngoscope. This will decrease the risk for laryngospasms. The use of curarizing agents should be avoided due to the possibility of worsening the hypoxia, since the child cannot maintain spontaneous breathing and, thus, suffer unsatisfactory oxygenation. In children aged greater than five years, anesthetic induction is performed with venous drugs; cases in which it is a little more difficult to maintain spontaneous breathing.36 As an alternative, bronchoscopy can be carried out with the patient in apneic status, with subsequent inflation and ventilation by positive pressure through the bronchoscope (which should be properly positioned). This approach requires a rapid and safe positioning of the bronchoscope and prompt removal of the foreign body before there is a fall in oxygen saturation.9
Rigid bronchoscopy

The rigid bronchoscope is the instrument of choice for the retrieval of foreign bodies in children. The procedure is initiated with the patient positioned supine and the neck slightly flexed. A plastic device or gauze should be used to protect the teeth and lips. The larynx is visualized with the assistance of the laryngoscope; the bronchoscope is introduced (direct visualization), and advanced through the vocal cords (making sure to twist it 90 degrees to avoid traumas to the delicate glottic mucous membrane of these patients). After the bronchoscope has been advanced past the subglottic region, the anesthetic and ventilation circuits should be connected to the bronchoscope. The instrument should be advanced slowly and carefully until the foreign body is located and retrieved. The telescope should be mounted at the end of the appropriate grasper, selected according to the type of foreign body, to allow direct visualization during the removal of the object. If a telescope is not available, the foreign body should be removed depending solely on the tactile sense of the endoscopist (it cannot be visualized after introduction of the grasper through the bronchoscope).

If the foreign body is sufficiently small to be retrieved through the bronchoscope, the grasper should be retrieved through the bronchoscope; usually, however, the foreign body is larger than the internal diameter of the bronchoscope. In the latter case, the grasper and the bronchoscope should be removed simultaneously. After complete removal of the bronchoscope, it should be reintroduced to aspirate all remaining secretions and to make sure that there are no fragments. Consequently, the permeability of the airways should be reestablished.

After the bronchoscopy, the child should remain hospitalized for at least 24 hours for observation of clinical evolution and for control radiological examinations. The doctor, the relatives, and the endoscopist should not expect the symptoms to promptly disappear during hospitalization; in almost all cases, the symptom of cough will remain. In case dyspnea persists for longer than 48 hours, and in the absence of other complications, the patient should be reexamined by bronchoscopy.

Children with laryngeal foreign bodies require special attention. In this sense, the professional should pay attention to the appearance of subcutaneous emphysema, which is a sign of bronchial trauma, since the risk for worsening of the upper airway obstruction is high. In the referred situations, it is recommended that the patient be transferred to an intensive care unit, since urgent tracheal intubation or even tracheostomy may be necessary. The use of antibiotic therapy should be restricted to cases of proven pneumonia or severe bronchial trauma; the use of systemic steroids for reducing edema in the mucosa is controversial.9

At times, additional therapeutic techniques may be required; for example, in cases of radiopaque foreign bodies lodged peripherally and in which the edema and granulation tissue hinder endoscopic visualization of the foreign body.37,38

Surgical removal of the foreign body

In his opening speech in the 1921 American Bronchoesophagological Association congress, Chevalier Jackson postulated that there would never be an indication for open surgical removal of airway foreign bodies. However, modern anesthetic and surgical techniques have increased the therapeutic modalities available. A review of 50 articles involving 6,393 patients with foreign body aspiration indicated that thoracotomy was necessary in only 161 cases (2.5%). In the same review, the author argues that not all patient information were available; review of 5,295 medical records indicated that tracheostomy was carried out in 104 cases (2.0%). Surgical interventions were performed in 52 of these patients (50%) due to edema of the larynx after bronchoscopy, in 11 to ventilation assistance, in 12 to introduction of the bronchoscope, and only in 10 to a foreign body too large to be removed through the glottis. Moreover, out of the 161 patients submitted to thoracotomy, 102 were submitted only to bronchotomy and 59 to lung resection due to bronchiectasis or chronic infections and abscess.38

Even in the hands of experienced endoscopists, there are situations in which endoscopic retrieval of airway foreign bodies should be abandoned in favor of open surgery; heroic measures can expose the patient to unnecessary risk of death. The main indications for open surgery are: 1) too large and rough objects lodged in the subglottal region or the trachea (more safely removed by tracheostomy, which avoids lesions to the subglottis and the vocal cords); 2) lodged grass, that can cause irreversible damage to the lungs and need for future lung resection; 3) foreign bodies lodged in the peripheral regions of the lung that cannot be reached endoscopically or radioscopically; and 4) objects whose risk of endoscopic retrieval is higher than the risk of open surgery.38 New techniques have been described such as that by Linch et al. who, in 1999, carried out the first known use of mediastinoscopy to remove a foreign body lodged in extraluminal position.37

Preventive aspects

New studies on aspiration of foreign bodies are indexed every day. Most of these studies emphasize diagnostic, clinical, radiological, and therapeutic aspects, and the success and complications of the procedures.2,7,16,17,23 In general, these studies do not comment on preventive aspects of foreign body aspiration, despite the fact that risk of total airway obstruction by a foreign body lodged in the larynx is associated with a mortality rate of approximately 45%.40

Patients asphyxiated due to transient obstruction of the airways may be at risk for hypoxic encephalopathy in
approximately 30% of cases. Fortunately, most victims of foreign body aspiration are capable of moving the lodged object by cough reflexes. Parents should learn about the Heimlich maneuver, in which sudden pressure is exerted on the lower ribs or upper abdomen from behind (patients > 4 years of age) or from behind with the patient positioned prone (infants) in the form of thrusts of sufficient force to help eject the foreign body. The Heimlich maneuver reduces the incidence of fatal accidents; other measures such as attempts to remove the object using the fingers and mouth-to-mouth resuscitation can turn a partial obstruction of the airways into total obstruction and are, thus, contraindicated.

The main preventive measures for foreign body aspiration are related to appropriate eating habits for age and to recommendations regarding the disposition, at home, of objects that children aged less than five years usually go for. Foods represent the most frequently aspirated category of foreign bodies (60% of cases).

Anatomical and cognitive factors are closely related to higher prevalence of foreign body aspiration in small children. The introduction of solid foods in diet usually occurs around four to 12 months of age. However, deliberate administration of certain foods such as peanuts, cashew nuts, corn, pop corn, and fruits with seeds, among others, to infants within this age range may result in aspiration due to their lack of proper teething (usually complete only at age four years). What is more, during the first six months of life, infants are feed almost exclusively by suckling; this type of feeding, however, may still remain for a few months, increasing the risk for aspiration of solid foods. To eliminate such foods from the diet of infants until the age of four years is a crucial measure for the reduction of such accidents. It is well-known that during the first year of life, children explore the world mouthing the most varied objects.

The aspiration of inorganic foreign bodies is less frequent and requires additional preventive measures, since it may occur in older children. First, it is important to inspect the settings where children spend most of their time. It is important to avoid loose small objects on the floor or within reach of children; for example, nails, screws, pen tops, and the like. Toys should be selected according to the age of children; younger children, or infants, for example, should be given toys that do not have small, removable parts. Also, at times children aspirate toys that belong to an older sibling and left within reach.

In 1989, in the United States, the Consumer Product Safety Commission created a test for the fixation of small toy parts. The test consists of determining the minimum dimensions of toy parts (such as building blocks) according to age; as a result, it was determined that toy manufacturers had to warn consumers about which products were safe for children aged less than three years, thus preventing cases of asphyxia. In April of 1990, the same Commission also required that warning labels be added to all packages of inflatable balloons, toys with small, ball-shaped parts or marbles, which were all associated with high mortality rates. Later on, the requirements for the warning labels were extended to toys for children up to six years of age.

In a review article including patients from eight pediatric hospitals in the US, 526 accidents of aspiration and ingestion of foreign bodies within a two-year period were analyzed. All 41 cases of death registered occurred at the home of patients. There were no reported cases of death in children who got to the hospital before neurological involvement. The conclusions presented by the author were emphatic: in dealing with prevention of death by asphyxia in small children, observing safety measures at home is fundamental.

Others have described the success of preventive programs involving the whole media through radio and television broadcasts, newspaper adds, and billboard advertisements, as in Israel. It is important to underscore that preventive programs should always be aimed at the specific segment of the population which is frequently affected by this type of accident.

In Brazil, the concern of the industry, the authorities, and the healthcare institutions in relation to the prevention of foreign body aspiration is still incipient. It is imperative that the Brazilian Ministry of Health and the State and City Departments of Health put forth educational campaigns aimed at the population as a whole. Scientific institutions, such as medical schools, unions, and scientific associations should also contribute, in separate or together with public institutions, to carrying out preventive campaigns.

Final comments

Table 1 shows the main study populations from the national and international literature on foreign body aspiration in pediatrics; the table also shows the common characteristics as related to the populations and to pediatrics. The studies shown in the table describe the epidemiological importance and the universal distribution of foreign body aspiration, independently of industrialization levels of countries and regions. Despite the prevalence of boys in these populations, it is suggested that foreign body aspiration also affects girls significantly (25% to 50% of cases). The distribution according to age group underscores that it is important to be watchful of children aged less than three years. Chest x-rays presented a good diagnostic value considering that their average sensitivity was in the 70 to 80% range. The data also confirms that there are cases of foreign bodies lodged in the left-side lung (healthcare professionals should be aware of such cases despite the prevalence of objects lodged in the right-side lung). The high prevalence of foods among the aspirated foreign bodies indicates the need to inform parents about the most adequate foods according to the age of children.
Table 1 - Summary of major studies about foreign body aspiration

<table>
<thead>
<tr>
<th>Author/country/time span(Ref.)</th>
<th>Cases (n)</th>
<th>Males (%)</th>
<th>Age (years - %)</th>
<th>Radiological abnormalities (%)</th>
<th>Location (organ - %)</th>
<th>Aspirated food (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chepote, Panama, 1970-1984(7)</td>
<td>97</td>
<td>63.0</td>
<td>&lt; 4 - 66.0</td>
<td>NR</td>
<td>NR</td>
<td>53.6</td>
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<td>Hugles, USA, 1939-1991(21)</td>
<td>234</td>
<td>63.0</td>
<td>&lt; 3 - 78.7</td>
<td>NR</td>
<td>NR</td>
<td>60.0</td>
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<tr>
<td>Aytaç, Turkey*(10)</td>
<td>500</td>
<td>66.0</td>
<td>&lt; 3 - 65.8</td>
<td>76.0</td>
<td>NR</td>
<td>78.1</td>
</tr>
<tr>
<td>Agarwal, Libya, 1985-1988(24)</td>
<td>76</td>
<td>55.0</td>
<td>&lt; 3 - 84.2</td>
<td>80.0</td>
<td>L and T: 9.6</td>
<td>82.8</td>
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<tr>
<td>Fraga, Brazil, 1989-1992(14)</td>
<td>26</td>
<td>57.0</td>
<td>&lt; 3 - 65.3</td>
<td>96.0</td>
<td>L and T: 11.5</td>
<td>50.0</td>
</tr>
<tr>
<td>Mu, China, 1982-1989(26)</td>
<td>400</td>
<td>54.0</td>
<td>&lt; 3 - 71.8</td>
<td>84.0</td>
<td>L and T: 13.0</td>
<td>95.5</td>
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<tr>
<td>Hoeve, Holland, 1980-1990(23)</td>
<td>85</td>
<td>73.0</td>
<td>NR</td>
<td>63.0</td>
<td>NR</td>
<td>NR</td>
</tr>
<tr>
<td>Toro, Brazil, 1988-1999(8)</td>
<td>273</td>
<td>51.0</td>
<td>30 months on average</td>
<td>NR</td>
<td>NR</td>
<td>NR</td>
</tr>
<tr>
<td>Blaser, Israel, 1966-1977(5)</td>
<td>200</td>
<td>66.5</td>
<td>&lt;3 – 85.0</td>
<td>84.4</td>
<td>L and T: 17.5</td>
<td>93.0</td>
</tr>
<tr>
<td>Piva, Brazil, 1986-1988(16)</td>
<td>19</td>
<td>73.7</td>
<td>34 months on average</td>
<td>57.9</td>
<td>L: 15.8</td>
<td>73.6</td>
</tr>
<tr>
<td>Black, USA, 1971-1992(42)</td>
<td>440</td>
<td>NR</td>
<td>&lt;3 – 79.0</td>
<td>83.0</td>
<td>RB: 49.0</td>
<td>73.8</td>
</tr>
<tr>
<td>Wiseman, Canada, 10 years(20)</td>
<td>157</td>
<td>66.6</td>
<td>&lt;3 – 80.0</td>
<td>81.5</td>
<td>RB: 54.0</td>
<td>NR</td>
</tr>
<tr>
<td>Skoulakis, Greece, 8 years(43)</td>
<td>130</td>
<td>NR</td>
<td>&lt;3 – 81.8</td>
<td>NR</td>
<td>RB: 60.0</td>
<td>96.1</td>
</tr>
<tr>
<td>François, France, 5 years(44)</td>
<td>335</td>
<td>66</td>
<td>&lt;3 – 77.0</td>
<td>100</td>
<td>L: 4.5</td>
<td>74.0</td>
</tr>
</tbody>
</table>

* the time span was not specified; NR = not reported; L = larynx; T = trachea; RB = right bronchus; LB = left bronchus

Considering that pediatric bronchoscopy requires a multidisciplinary, specialized team, it is clear to us that this procedure requires thus well-trained, qualified professionals. Moreover, medical services should be structured so as to provide a minimum standard of assistance to all patients in relation to offering space distribution and availability of principal and additional equipment, and to being supported by other services, such as intensive care units.
References

