

## Mechanisms of Unexpected Death in Infants and Young Children Following Foreign Body Ingestion

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**ABSTRACT:** Fatal foreign body ingestion in childhood usually results in sudden and unexpected death from acute upper airway occlusion. The most common age range for such episodes is one to three years. However, a variety of different mechanisms of death due to ingested foreign bodies may occur in children, including hemorrhage, acute cardiac tamponade, arrhythmia, centrally mediated respiratory arrest and sepsis. Sudden death may follow a protracted asymptomatic period and may also be due to foreign bodies impacted in the esophagus. A review of cases has been undertaken ( $N = 10$ ; age = three and one-half months to seven years; M:F = 9:1), which demonstrates the variety of lethal processes that may occur, the range of materials involved and the different anatomical sites where problems can result.

**KEYWORDS:** forensic science, airway obstruction, sudden childhood death, foreign body, tamponade

Although most fatal episodes of foreign body ingestion in children involve asphyxia from airway obstruction, a variety of other less common processes may also result in unexpected death and thus come to the attention of the forensic pathologist. Review of the following cases illustrates the range of causes and associated autopsy findings in sudden/unexpected death in infants and children following foreign body ingestion. Details of three of the cases (Cases 7, 8, and 10) have been previously published (1-3).

### Case Reports

#### Case 1

An 18-month-old girl suffered cardiorespiratory arrest at a friend's home following impaction of a 33 mm plastic ball in her oropharynx (Fig. 1). In spite of resuscitation, brain death was diagnosed several days later in the hospital. Autopsy revealed widespread diffuse hypoxic-ischemic encephalopathy secondary to the asphyxial episode.

#### Case 2

A 13-month-old boy was taken to the Emergency Department, having collapsed following inhalation of a plastic chess piece.

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FIG. 1—A 33 mm plastic ball which caused the death of an 18-month-old girl (described in Case 1) following impaction within the oropharynx.

During unsuccessful resuscitation a plastic pawn was found within the larynx above the cricoid cartilage. At autopsy, submucosal hemorrhage of the hypopharynx was noted.

#### Case 3

A 15-month-old boy was found dead on the floor of his parents' bedroom, having last been seen sleeping on their bed. At autopsy, a 2-cm woodscrew was found in his larynx, the head at the level of the vocal cords and the tip within the upper trachea.

#### Case 4

A 19-month-old boy collapsed and died at home after choking on a handful of peanuts. At autopsy a peanut was extracted from his trachea.

#### Case 5

A three and one-half-month-old boy collapsed at home following ingestion of an aspirin tablet and died soon after in hospital. At autopsy the tablet was found wedged within the right main bronchus (Fig. 2).



FIG. 2—An aspirin tablet (arrow) within the right main bronchus, which caused the death of a three- and one-half-month-old boy (described in Case 5).

#### Case 6

An eight-month-old boy collapsed and died at home while eating minced meat. At autopsy both main bronchi were occluded by meat.

#### Case 7

A four-month-old, previously well, boy was found dead in his cot. At autopsy a one cent piece was found impacted in the esophagus 35 mm above the level of the carina with compression of the adjacent trachea. (The pathological features of this case have been previously reported (1).)

#### Case 8

A 19-month-old boy was found to have died while eating a sausage. No coughing or evidence of choking had been noted by his caretaker. At autopsy a 30 mm diameter piece of the sausage was found in the lower esophagus. (Details of this case have also been reported previously (2).)

#### Case 9

An eight-month-old boy with a one day history of a febrile illness attributed to an upper respiratory infection died suddenly in a doctor's office. At autopsy an open safety pin was found piercing the anterior wall of the lower esophagus and extending into the left ventricle causing a hemopericardium (Fig. 3).

#### Case 10

An otherwise-well, mentally retarded seven-year-old boy suddenly developed a fever with fitting. Death occurred several hours

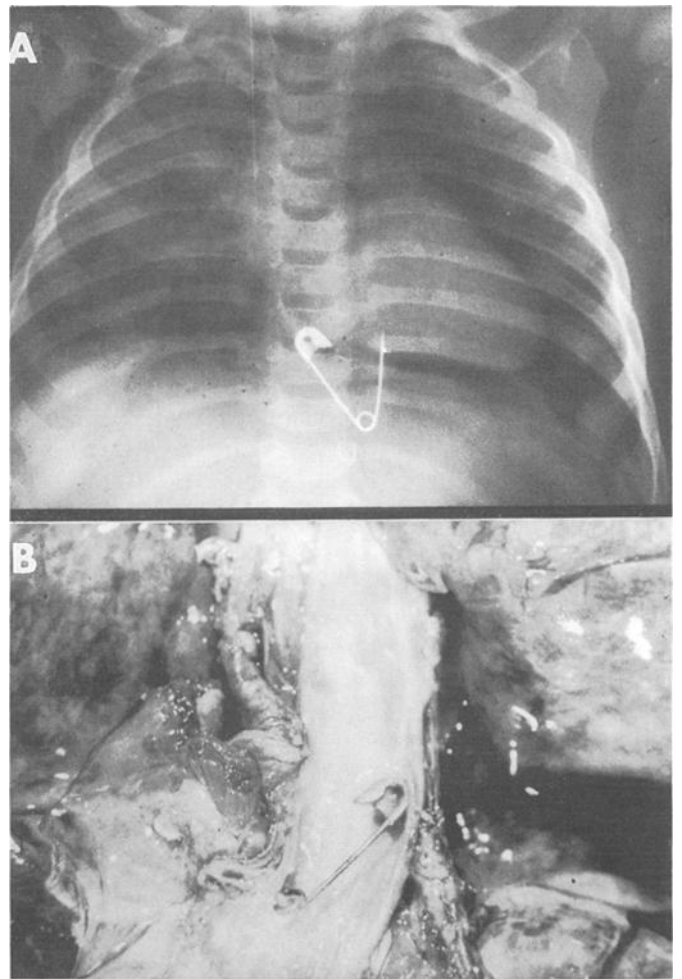


FIG. 3—A chest X-ray (A) demonstrating the position of an open safety pin that had pierced the anterior wall of the esophagus (B) and posterior wall of the left ventricle causing cardiac tamponade.

later in hospital. Autopsy examination revealed a woodscrew within retroperitoneal tissues with an associated septicemia. The point of gastric or intestinal perforation was not identified. (Details of this case have also been reported previously (3).)

#### Discussion

Under certain circumstances, infants and young children are at risk of sudden death from impaction of foreign material in their upper aerodigestive tracts. Children aged between one and three years are more vulnerable than younger or older children due to a combination of factors including recently increased mobility, inability to judge the appropriateness of placing small objects in their mouths, small airways and inadequate dentition for adequately chewing material (4,5). Specifically, children at this age develop their incisor teeth before their molars and so are able to bite off portions of hard food without being able to reduce the size and firmness by grinding. Careful assessment of dentition is therefore a requirement at autopsy in these cases (2). Ninety percent of fatal choking on foreign bodies occur before the age of five years (6). Most fatal cases involve asphyxia from obstruction of the upper airway by either food, coins or toy parts (7-9), however, this series demonstrates that sudden/unexpected death due to ingested foreign

bodies may also rarely occur in younger infants and in older children by a variety of other mechanisms.

Acute asphyxia may occur if a foreign body occludes any part of the upper airway from the oropharynx to the major bronchi, as demonstrated in Cases 1 to 6. The usual presentation is of sudden collapse while eating or playing, and autopsy examination will reveal the occluding foreign body unless it has been removed during attempted resuscitation. In these cases, it is essential to obtain a full clinical history and to secure the foreign body for assessment and documentation. Conditions predisposing to fatal aspiration include running while eating, and eating foods that may not have been encountered before, in environments with low numbers of supervising adults and numerous other children. This may be of particular concern in child-care centers where the so-called 'creche coronary' syndrome mimics the café coronary syndrome of adults (10,11). The most commonly encountered foods causing fatal airway occlusion are those with rounded shapes and firm to hard consistencies such as hot dogs, hard candy, peanuts, grapes, raw carrots and popcorn (6,8,12).

Eight of the foreign bodies in the current series were identified at autopsy, two having been removed during attempted resuscitation. In four cases there had been no suspicion of a foreign body until the autopsy was performed. In one case the diagnosis of SIDS

was being entertained (Case 7). This demonstrates once again the importance of complete autopsy examinations for accuracy of diagnosis in all cases of unexpected infant and childhood deaths.

Asphyxia may also result from foreign bodies that lodge in the esophagus due to compression of the adjacent trachea. As demonstrated in Case 7 this effect may not be immediate but may occur after some time, in the absence of a suggestive history (1). A similar asymptomatic period may occur with foreign bodies lodged in the tracheobronchial tree (13).

The role of reflex vagal stimulation in contributing to sudden death following ingestion of foreign material is difficult to assess. However, the rapidity with which death occurs in adults who suffer a café coronary suggests that cardiac arrhythmia, rather than airway occlusion, is the more likely terminal event (14). In infants it has been proposed that esophageal dysmotility may cause cardiorespiratory arrest secondary to a vasovagal reflex mechanism (15), and experimental observations have shown that instilling dilute acid into the esophagus of infants causes bradycardia and apnea (16). Animal studies have also demonstrated reflex apneas following intralaryngeal and intraesophageal fluid instillation (17-20), giving support for reflex neurological mechanisms as a possible cause of death in cases of foreign body impactions. Thus, while the cause of death in Case 8 may have been asphyxia due to compression

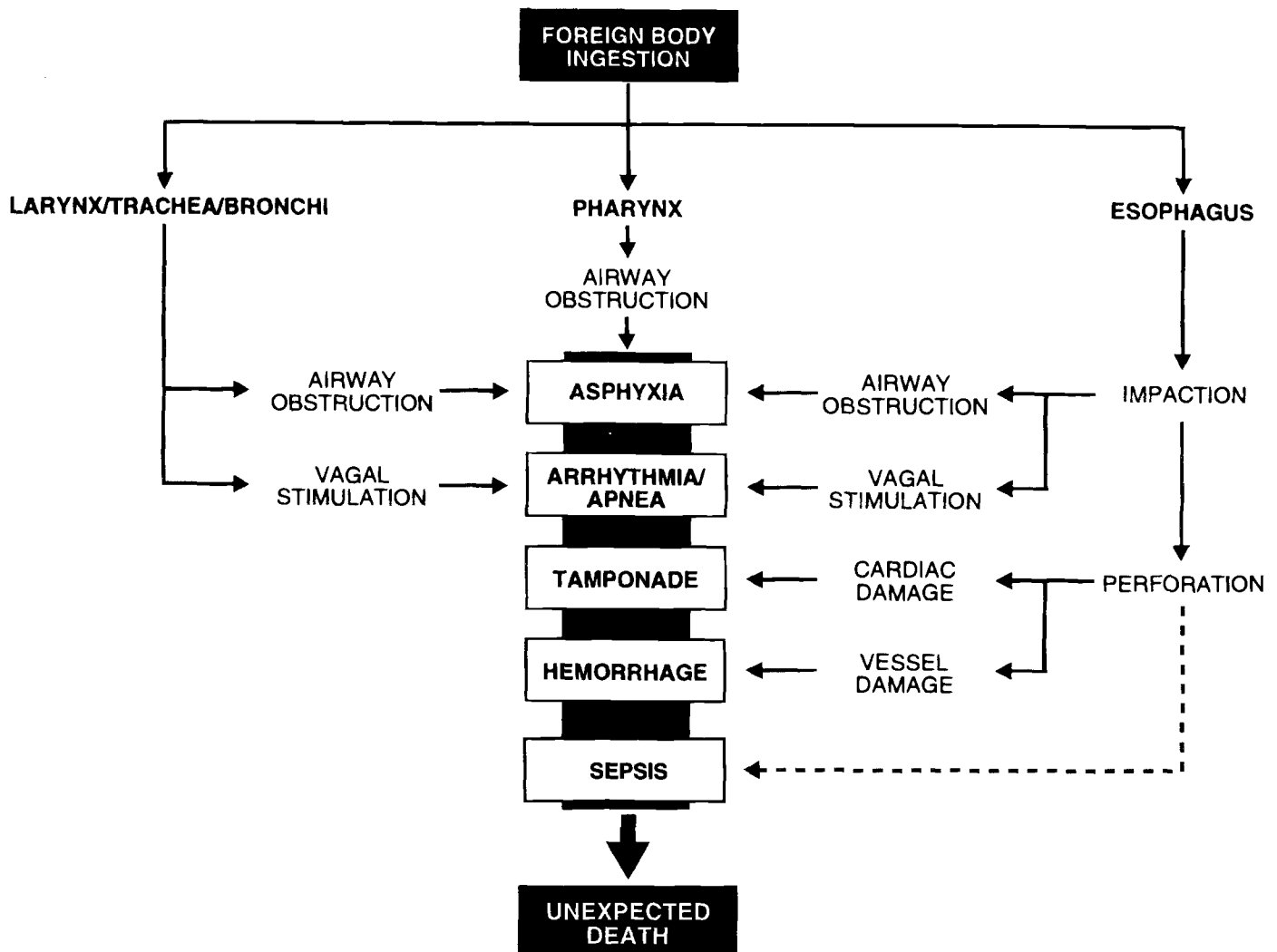


FIG. 4—A summary of possible causes and mechanisms of sudden/unexpected death in childhood following foreign body ingestion.

of the membranous portion of the trachea by a large bolus of intraesophageal food, reflex vagal mechanisms may also have contributed to the fatal episode. Support for this is gained from the apparent absence of coughing or choking prior to death. However, it should be noted that other studies have failed to demonstrate a temporal relationship between gastroesophageal reflux and apnea in infants (21), or an association between reflux and clinical outcome (22,23). In addition, it may not necessarily be possible to extrapolate from infant and animal studies to older children.

Less commonly, death results from foreign body migration. In children, migration of foreign material has occurred from the pharynx and all levels of the esophagus, with death resulting from aortic and innominate artery erosion, carotid artery thrombosis, stroke and parapharyngeal sepsis (24). Death from acute cardiac tamponade has been described following ingestion of safety pins (25,26), and was demonstrated in Case 9 where an opened safety pin had pierced the anterior wall of the esophagus, the pericardium and the left ventricle causing fatal tamponade. Death from aorto-esophageal fistula formation may also occur due to massive uncontrolled hemorrhage.

Although fatal sepsis may also result from migrating foreign material (23), this does not usually present as unexpected death unless there are confounding factors such as mental retardation or neglect (3). For example, although fulminant sepsis occurred in Case 10 following migration of a woodscrew into the retroperitoneum, it is possible that significant mental retardation may have masked preceding symptoms.

These cases demonstrate that the causes of sudden childhood death following ingestion of a foreign body may be quite diverse and involve a range of mechanisms. A summary of possible pathways that may lead to death in children who have ingested foreign material is included in Fig. 4.

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