Foreign Body Aspiration
The Perpetual Epidemic

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Swallow: Foreign Bodies, Their Ingestion, Inspiration, and the Curious Doctor Who Extracted Them
Mary Capello
"The main task of the educator is to make sure the medical student stays awake"
Chevalier Jackson M.D.

There are three kinds of people in the world. The kind of people that can count. And the kind of people that can't. - Steven Wright - Comedian

Case 1

Toddler witnessed choking on hotdog
Cyanotic, unresponsive
Dad tried blind finger sweeps, mouth-to-mouth, CPR
EMS – attempted BMV and CPR enroute to ER
60 min. later, pronounced dead
Autopsy, chunk of hot dog in glottis
Case 2
14 y.o. male
C.C: “asthma”
Sudden onset 6 mo. prior
“Wheezing”, worse with activity and
“It’s worse whenever I (stridorous breath)
lay down or exercise (stridorous breath)”
3 ER visits, “wheezing shot and steroids”
No radiographs
On questioning “might have choked on a bug last
summer”

Case 3
18 month old boy coughing intermittently 2 weeks
History of URI’s
3 days of worsening
Still coughing intermittently, especially at night
P.E. Afebrile, no distress
Wheezeing localized to right upper lobe
On further questioning did cough during eating
popcorn recently
Epidemiology; Aspirated F.B. in Children

Most cause of common accidental deaths < 1 y.o.

7% of deaths of children under 4 y.

17,000 E.R. cases/year (<14 y.) - U.S.
3-4% Mortality (1000- 4000 deaths/year)
15-20% Complication rate (greater if delayed)

Foreign Body Aspiration


**Complications**

<table>
<thead>
<tr>
<th>Complications</th>
<th>Number of articles</th>
<th>Cases</th>
<th>Total number of cases</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pneumonia</td>
<td>13</td>
<td>27</td>
<td>1,171</td>
</tr>
<tr>
<td>Lung abscess empyema</td>
<td>2</td>
<td>9</td>
<td>18</td>
</tr>
<tr>
<td>Larynx edema</td>
<td>6</td>
<td>42</td>
<td>634</td>
</tr>
<tr>
<td>Respiratory insult</td>
<td>6</td>
<td>27</td>
<td>427</td>
</tr>
<tr>
<td>Pneumothorax pneumonitis</td>
<td>8</td>
<td>27</td>
<td>1,171</td>
</tr>
<tr>
<td>Cardiopulmonary arrest</td>
<td>1</td>
<td>27</td>
<td>1,171</td>
</tr>
<tr>
<td>Pulmonary edema</td>
<td>5</td>
<td>7</td>
<td>653</td>
</tr>
<tr>
<td>Complications overall</td>
<td>35</td>
<td>385</td>
<td>3,255</td>
</tr>
</tbody>
</table>

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**Presentation - Characteristics**

- **Airway Site**
- **Size/Shape**
- **Composition**

“There are three types of lies; Lies, damned lies and statistics”

Mark Twain

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**Presentation - Timing**

- **Asphyxiating**
  - Laryngo-tracheal
  - Conforming
  - Large

- **Delayed**
  - Small airway (<5mm)
  - Pneumonia
  - Atelectasis

- **Immediate Distress**
  - Bronchial
  - Persistent cough
  - Wheeze

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Location

3% Larynx
10% Trachea
75% Bronchi – 2/3 proximal
56% Right?
44% Left
1-2 % Lung


### Aspirated Objects - Organics

#### “Proper Food” - 65%
- Nuts*
- Seeds*
- Popcorn
- Raw carrots
- Beans
- Peas
- Hot dogs, Grapes, Hard Candy**

*“If had been up to him (Chevalier Jackson), parents who gave nuts to children without molars would be drawn and quartered”*

Mary Capello – Biography of Chevalier Jackson
Aspirated Objects - Inorganics

**Non-foods** – 25%
- Beads, balls, marbles, pebbles*
- Cellophane, foil, wraps*
- Balloons*
- Pins
- Caps
- Crayons
- Toys
- Lego’s*

“A button box makes a poor play toy”
Chevalier Jackson M.D.

Response to Aspirated F.B.

**Triple Response**
1. Penetration Syndrome
   - Classic Triad - laryngospasm, cough, distress
2. Silent period
3. Delayed symptoms
   - Persistent cough
   - Wheeze
   - Atelectasis
**Range of Symptoms**

<table>
<thead>
<tr>
<th>Symptoms and clinical signs</th>
<th>Number of cases</th>
<th>Percentage</th>
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</thead>
<tbody>
<tr>
<td>Stridor</td>
<td>10</td>
<td>5.3</td>
</tr>
<tr>
<td>Persistent nocturnal cough</td>
<td>20</td>
<td>11.4</td>
</tr>
<tr>
<td>Persevering cough</td>
<td>15</td>
<td>9.3</td>
</tr>
<tr>
<td>Persistent cough</td>
<td>12</td>
<td>7.4</td>
</tr>
<tr>
<td>Barking cough</td>
<td>8</td>
<td>5.1</td>
</tr>
<tr>
<td>Wheeze</td>
<td>11</td>
<td>8.9</td>
</tr>
<tr>
<td>Non-stop stridor</td>
<td>12</td>
<td>9.8</td>
</tr>
<tr>
<td>Recurrent or persistent respiratory infections</td>
<td>25</td>
<td>21.5</td>
</tr>
<tr>
<td>Dysphonia</td>
<td>1</td>
<td>0.8</td>
</tr>
<tr>
<td>Hypersalivation</td>
<td>4</td>
<td>3.7</td>
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<tr>
<td>Chronic cough</td>
<td>1</td>
<td>0.8</td>
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<tr>
<td>Socioeconomic status (age, class, status, occupation, conditions, disorder)</td>
<td>11</td>
<td>9.8</td>
</tr>
<tr>
<td>Subscapular scoliosis</td>
<td>11</td>
<td>9.8</td>
</tr>
<tr>
<td>Pulmonary examination</td>
<td>11</td>
<td>9.8</td>
</tr>
<tr>
<td>Normal</td>
<td>11</td>
<td>9.8</td>
</tr>
<tr>
<td>Reduced muscular tone</td>
<td>11</td>
<td>9.8</td>
</tr>
<tr>
<td>Wheezing breath</td>
<td>11</td>
<td>9.8</td>
</tr>
<tr>
<td>Hoarseness</td>
<td>11</td>
<td>9.8</td>
</tr>
</tbody>
</table>


**Abnormal Breath Sounds of Foreign Bodies**

- **Stridor** – Auscultate the neck
- **Biphasic**
- **Fixed**

- **Localized Wheeze**
  - Especially if in more than one segment

- **Localized diminished breath sounds**

"A physician without knowledge of pulmonary function is like a donut without a hole."  Chevalier Jackson M.D.
<table>
<thead>
<tr>
<th>Foreign Body</th>
<th>No Foreign Body</th>
<th>p</th>
<th>PPV</th>
<th>NPV</th>
<th>Se</th>
<th>Sp</th>
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</thead>
<tbody>
<tr>
<td>History of choking</td>
<td>34</td>
<td>36</td>
<td>NS*</td>
<td>0.34</td>
<td>0.68</td>
<td>0.60</td>
</tr>
<tr>
<td>Cough</td>
<td>32</td>
<td>29</td>
<td>NS*</td>
<td>0.53</td>
<td>0.65</td>
<td>0.60</td>
</tr>
<tr>
<td>Dyspnea or apnea</td>
<td>20</td>
<td>17</td>
<td>NS*</td>
<td>0.54</td>
<td>0.57</td>
<td>0.50</td>
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<tr>
<td>Cough</td>
<td>11</td>
<td>15</td>
<td>NS*</td>
<td>0.42</td>
<td>0.69</td>
<td>0.40</td>
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<tr>
<td>Abdominal</td>
<td>27</td>
<td>16</td>
<td>≤ 10^{-9}</td>
<td>0.63</td>
<td>0.68</td>
<td>0.68</td>
</tr>
<tr>
<td>Abdominal</td>
<td>28</td>
<td>3</td>
<td>≤ 10^{-9}</td>
<td>0.74</td>
<td>0.75</td>
<td>0.63</td>
</tr>
</tbody>
</table>

Radiographic Findings in Aspirated Foreign Bodies

- **Stop Valve**
  - Complete obstruction
  - Atelectasis

- **Bypass Valve**
  - Partial obstruction
  - Normal?

- **Check Valve**
  - Expiratory obstruction
  - Hyperinflation

“All mankind is divided into three groups: those that are immovable, those that are movable and those that move.”

Benjamin Franklin
Reliability of Radiographic Findings for Foreign Bodies

Table 2 Radiographic appearance of bronchial foreign bodies according to various series, results expressed as a percentage

<table>
<thead>
<tr>
<th></th>
<th></th>
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<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Radioopac</td>
<td>38.7</td>
<td>13.7</td>
<td>7.69</td>
<td>6.25</td>
<td>19.7</td>
<td>4</td>
<td>--</td>
</tr>
<tr>
<td>Abscess</td>
<td>4.9</td>
<td>25</td>
<td>25</td>
<td>22</td>
<td>12.5</td>
<td>15.3</td>
<td>19.6</td>
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<tr>
<td>Emphyema</td>
<td>17.1</td>
<td>31</td>
<td>31</td>
<td>41.4</td>
<td>68.8</td>
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<td>Pneumonia</td>
<td>6.7</td>
<td>11.8</td>
<td>11.8</td>
<td>11.8</td>
<td>56.3</td>
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<tr>
<td>Normal</td>
<td>21.1</td>
<td>30</td>
<td>37</td>
<td>18.4</td>
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</table>

Chest Xrays in Foreign Bodies

<table>
<thead>
<tr>
<th>Findings</th>
<th>Sens. (%)</th>
<th>Spec. (%)</th>
<th>Sens. (%)</th>
<th>Spec. (%)</th>
<th>Sens. (%)</th>
<th>Spec. (%)</th>
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</thead>
<tbody>
<tr>
<td>Penetration syndrome</td>
<td>75.4</td>
<td>10.1</td>
<td>10.5</td>
<td>88.3</td>
<td>13.6</td>
<td>91.4</td>
</tr>
<tr>
<td>Chest examination</td>
<td>66.6</td>
<td>12.3</td>
<td>13.8</td>
<td>86.0</td>
<td>14.8</td>
<td>91.2</td>
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<tr>
<td>Chest radiograph</td>
<td>88.3</td>
<td>13.6</td>
<td>13.6</td>
<td>88.3</td>
<td>13.6</td>
<td>88.3</td>
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<tr>
<td>Chest CT</td>
<td>66.6</td>
<td>12.3</td>
<td>13.8</td>
<td>86.0</td>
<td>14.8</td>
<td>91.2</td>
</tr>
</tbody>
</table>

A. Martinot et al. AM J RESPIR CRIT CARE MED 1997;155:1676-1679.

Reliability of Findings

<table>
<thead>
<tr>
<th>Findings</th>
<th>Sens. (%)</th>
<th>Spec. (%)</th>
<th>Sens. (%)</th>
<th>Spec. (%)</th>
<th>Sens. (%)</th>
<th>Spec. (%)</th>
</tr>
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<td>75.4</td>
<td>10.1</td>
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<td>91.2</td>
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• “There are three kinds of lies; lies, damned lies and statistics.” Mark Twain

3 Choices for Suspected Foreign Bodies
1. Do nothing and watch
   - No coughing, Normal exam
   - Normal Chest Xray

2. Rigid bronchoscopy?

3. Flexible Bronchoscopy?

“There are 3 kinds of people in the world;
The kind that can learn by reading,
The few that can learn by experience
And those that just have to pee on the electric fence.”
Will Rodgers

Rigid Bronchoscopy

Pro’s
- Excellent visualization
- Object retrieval
- Instrumentation
- Ventilation

Con’s
- General anesthesia
- Invasive (8-17% complication rate)
- Airway trauma
Flexible Bronchoscopy

**Pros**
- Less invasive
- Less traumatic
- Full inspection of lower airways

**Cons**
- Less instrumentation
- Non-ventilating
- Sedation still necessary

Flexible Fiberoptic Bronchoscopy

<table>
<thead>
<tr>
<th>Bronchoscope</th>
<th>Outer diameter (mm)</th>
<th>Suction channel diameter (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ultrathin</td>
<td>2.2</td>
<td>N/A</td>
</tr>
<tr>
<td>XP40</td>
<td>2.7</td>
<td>1.2</td>
</tr>
<tr>
<td>3C30</td>
<td>3.5</td>
<td>1.2</td>
</tr>
<tr>
<td>Pentax FB 15X</td>
<td>4.9</td>
<td>2.2</td>
</tr>
</tbody>
</table>

Rigid Bronchoscopy – Retrieve

Positive physical – stridor, distress, localized wheeze
  (Remember to auscultate the neck)

Positive chest radiograph
  - Opaque object
  - “Cut off”
  - Focal or unilateral hyperinflation
Flexible Bronchoscopy – inspection (retrieve?)

- Equivocal findings on history or physical
- Witnessed event
- Chronic cough
- Questionable radiographic findings
- Inspection post-rigid

Flexible Bronchoscopy for Foreign Body Removal

- Surgery backup
- 4.5 ET tube
- Ventilating Well
- No bleeding

Table 1  Case series of bronchosfordoscopic foreign body removal

<table>
<thead>
<tr>
<th>No</th>
<th>Success (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>300</td>
<td>89</td>
</tr>
<tr>
<td>33</td>
<td>97</td>
</tr>
<tr>
<td>23</td>
<td>61</td>
</tr>
<tr>
<td>43</td>
<td>74</td>
</tr>
<tr>
<td>58</td>
<td>97</td>
</tr>
<tr>
<td>457</td>
<td>83.6</td>
</tr>
</tbody>
</table>
Children with suspected foreign body aspiration

1. Asphyxia?
   - Yes: Rigid bronchoscopy
   - No: (8)

2. Radiopaque foreign body?
   - Yes: Rigid bronchoscopy (8 FB +)
   - No: (75)

3. Unilateral decreased breath sounds or obstructive emphysema?
   - Yes: Rigid bronchoscopy (15 FB +)
   - No: (59)

Flexible bronchoscopy (17 FB +)
   - No: (42: absence of FB)

History of choking

No present cough
Normal lung (and throat) sounds
Normal Chest Xray (no Inspiratory/expiratory films)

Watchful waiting

Yes

No

Visible foreign body
Compromised airway/distress

Rigid Bronchoscopy

Flexible bronchoscopy

CT scan?
Prevention of Foreign Body Aspiration

*6 month visit* – discussions about foods, toys
Choking first aid (Red Cross poster)

< 1 year – smooth foods only; feed sitting

Beware of siblings (and well meaning friends, family)
### Treatment of Laryngeal Foreign Body

<table>
<thead>
<tr>
<th>Coughing, Making Noise</th>
<th>Not Coughing, No Noise</th>
</tr>
</thead>
<tbody>
<tr>
<td>No intervention</td>
<td>- “5 and 5”</td>
</tr>
<tr>
<td></td>
<td>5 Backblows, 5 Heimlichs</td>
</tr>
<tr>
<td></td>
<td>- Repeat</td>
</tr>
<tr>
<td></td>
<td>- Visible object remove</td>
</tr>
<tr>
<td></td>
<td>- NO blind finger sweeps</td>
</tr>
<tr>
<td></td>
<td>- Unresponsive start CPR</td>
</tr>
</tbody>
</table>

*American Heart Association; American Academy of Pediatrics*

### Heimlich

Alfredo fails to understand the proper way to perform a Heimlich.

### Heimlich Maneuver

1. **Give 5 backblows:**
   - Stand behind the person.
   - Open mouth and nose with fingers.
   - Blow into the mouth until the chest rises.
   - Repeat 5 times.

2. **Do 5 abdominal thrusts:**
   - Stand by the person's side.
   - Grasp hands on the person’s abdomen, just above the navel.
   - Make a quick upward thrust into the abdomen.
   - Repeat 5 times.

3. **Repeat steps 1 and 2 until the:**
   - Object becomes visible and can be removed.
   - Breathing or circulation returns.

**What to do next:**
- Call 911 or emergency services.
- Continue CPR if necessary.
- If object not removed, repeat the Heimlich maneuver.
Prevention of Foreign Body Aspiration

< 1 year – smooth foods only; feed sitting

< 4 years (or molars)
- NO nuts, seeds, popcorn
- NO unpeeled fruit
- NO grapes, hot dogs
- NO carrots, hard candies, M&M’s
- Gummi bears?
- Remove seeds (watermelon)

Activity During Aspiration

- NO Eating while playing, running

Prevention of Foreign Body Aspiration

Age appropriate toys - > 1.75 in. spheres
(golf ball size)

Dispose of wrapping, packaging, paper
- Tour the house after parties, holidays

< 8 years – NO balloons
Prevention of Foreign Body Aspiration

Advocacy –
- Parent education
- Foods and packaging
- Small parts legislation and adherence
- Magnets, batteries
- Public awareness

Asphyxiating Foreign Body - Laryngeal

Emergency Management
- Direct laryngoscopy
- Ring forceps
- Alligator forceps

“Every infant injury, every dead child, is something utterly intolerable. We should bear in mind the objective to avoid as many of these infant injuries as possible.”
The Suzy Safe Working Group
Asphyxiating Foreign Body - Laryngeal

Emergency Management
- Needle Cricothyrotomy
- 12-14 gauge
- Commercial Devices
- Seldinger Techniques
- Surgical Techniques

Complications
- Bleeding
- Non-placement
- Posterior wall laceration
- Esophageal perforation
- Pneumo-mediastinum
- Pneumothorax
- Hypercarbia