

Caustic Ingestion

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Target Audience: Emergency Medicine Residents (junior and senior level postgraduate learners), Medical Students

Primary Learning Objectives:

1. Identify intentional versus unintentional caustic ingestions
2. Recognize signs of impending airway compromise and intubate early if necessary
3. Consult with Gastroenterology (GI) early for prognostic esophagogastroduodenoscopy (EGD)
4. Recognize and identify signs of perforation and consult surgery as needed
5. Order appropriate imaging and laboratory studies

Secondary Learning Objectives: detailed technical/behavioral goals, didactic points

1. Describe the difference between acidic and alkaline chemicals
2. Describe role of activated charcoal (AC) in caustic ingestions
3. Identify limitations of physical exam findings as predictors of esophageal injury
4. Describe management differences for pediatric unintentional caustic ingestions vs intentional ingestions
5. Describe the role of antibiotics for caustic ingestion

Critical actions checklist:

1. Perform early endotracheal intubation
2. Order chest X-ray (CXR)
3. Avoid attempts at GI decontamination
4. Obtain early GI consultation
5. Consider perforation when patient deteriorates
6. Consult Poison Center/Toxicologist
7. Administer antibiotics
8. Consult Surgery

Environment: Emergency Department treatment area

1. Room Set Up – ED noncritical care area
 - a. Manikin Set Up – Mid or high fidelity simulator, simulated sweat, simulated oropharyngeal swelling
 - b. Props – Standard ED equipment
2. Distractors – ED noise, patient's ex-girlfriend in room and hysterical

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CASE SUMMARY

SYNOPSIS OF HISTORY/ Scenario Background

This takes place in a tertiary care center.

The patient is a 17-year-old male with a history of depression and prior alcohol abuse who presents to the emergency department with his ex-girlfriend after ingesting “Poolife Rapid Shock.” The patient’s ex-girlfriend says they recently broke up, and he called her after drinking about half of a 1L bottle of the pool cleaner in an attempt at self-harm. The patient is alert but not talking.

PMH: depression, prior alcohol abuse

PSHx: none

Medications: fluoxetine

Allergies: no known drug allergies

SH: Prior alcohol abuse, social smoker, lives with parents and is in high-school

SYNOPSIS OF PHYSICAL

- Patient is anxious. His vitals are significant for tachycardia and tachypnea.
- His mucous membranes are edematous, there are visible partial thickness burns of the lips, tongue, and posterior oropharynx; he has stridor and drooling
- Neurologic exam is non-focal. He is alert but not talking, follows commands
- Skin is diaphoretic.

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HISTORY

You are called to see a new patient (17-year-old male) in the pediatric area of the emergency department. You see a diaphoretic male who is alert, but breathing rapidly and not talking.

Onset of Symptoms: Today

Background Info: 17-year-old male with a history of depression and prior alcohol abuse who presents to the emergency department with his ex-girlfriend after ingesting "Poolife Rapid Shock." The patient's ex-girlfriend says they recently broke up, and he called her after drinking about half of a 1L bottle of "Poolife Rapid Shock" in an attempt at self-harm. History cannot be obtained from the patient because he is not talking.

Additional History

From Ex-Girlfriend: He has had some problems with alcohol in the past, but he has been sober for over a year. They broke up last week and he has been taking it really hard. She knows he has depression.

Chief Complaint: Mouth pain

Past Medical Hx: prior alcohol abuse, depression

Past Surgical Hx: none

Habits: Smoking: Occasional
ETOH: prior abuse, sober for 1 year
Drugs: none

Family Med Hx: Diabetes, CVA

Social Hx: Marital Status: Single
Children: None
Education: High School
Employment: Unemployed

ROS: Patient is unable to answer.

CASE CONTINUATION

The ex-girlfriend is hysterical and continuously asks if he is going to be ok.

Vital Signs: BP: 110/73 mmHg P: 122/minute R: 27/minute T: 37.1C (98.6F) POx: 98% (FiO₂=0.21)

Primary Survey

Airway – Lips swollen and burned, tongue swollen, posterior oropharyngeal edema and erythema, saliva pooling in the mouth

Breathing – Tachypnea, stridor, 100% POx

Circulation – Tachycardia (120s/minute), SBP 110s mmHg

Disability – Patient is alert but not talking, in some obvious distress

Exposure – No trauma, rash, drug patches. Patient is diaphoretic

Required Actions within the First Two Minutes

- Establish safety net (IV, oxygen, cardiac monitor, two large bore IVs, draw blood for labs)
- A/B – Provide supplemental oxygen
- C – Cardiac monitor; NS IV bolus; ECG
- D – Finger stick glucose = 121 mg/dL; diagnostics should be ordered by this time

Branch Points

- **IF PATIENT IS NOT INTUBATED**, then his stridor worsens. **IF HE REMAINS UNINTUBATED FOLLOWING THE ONSET OF STRIDOR**, then his airway will obstruct, and he will enter respiratory arrest.

PHYSICAL EXAMINATION

General Appearance: Pale, diaphoretic male. Unresponsive.

Vital Signs: BP: 110/73 mmHg P: 122/minute R: 27/minute T: 37.1C (98.6F) POx: 98% (FiO₂=0.21)

Head: Normal

Eyes: Pupils equal, round and reactive to light, pupils 3 mm bilaterally

Ears: Tympanic membranes are normal.

Mouth: Partial thickness burns to the upper and lower lips, edematous tongue and posterior oropharyngeal edema and erythema with saliva pooling in the mouth

Neck: No tenderness or deformity on exam, full range of motion

Skin: Moist skin/sweaty, no rashes, warm

Chest: Increased respiratory rate without any accessory muscle use

Lungs: Clear, equal bilaterally

Heart: Tachycardic, S1 S2, no murmurs

Back: Normal

Abdomen: Soft, nontender, no signs of trauma, no rebound/guarding, normal bowel sounds

Extremities: No signs of trauma, no edema, pulses are present

Genital: Normal male genitalia

Rectal: Normal tone, guaiac negative

Neurological: Non-focal exam, no clonus

Mental Status: Alert and following commands but not talking

Required Actions within the Next Two Minutes

- Obtain CXR, assess for tube placement, signs of aspiration pneumonitis, signs of perforation
- Should send basic labs including CBC, BMP, lactate, ASA, APAP; obtain ECG
- Call Poison Center or Toxicologist
- Consult GI

Branch Points

- **IF POISONCENTER/TOXICOLOGIST IS CALLED**, then the Poison Center/Toxicologist should tell participants that “Poolife Rapid Shock” has chlorine and is converted to hydrochloric acid when it makes contact with water

CASE CONTINUATION

- The patient’s hemodynamics worsen: he becomes more tachycardic to the 120s-130s/minute, and his BP drops to SBP 70s mmHg despite fluid resuscitation.
- His repeat exam is essentially unchanged aside from a somewhat distended abdomen that is tense
- His initial lactate is 6.2

Required Actions within the Next Several Minutes

- Start patient on vasopressors (can attempt more fluids, but his BP will be unresponsive)
- Consult Surgery emergently for suspected perforation (can obtain imaging first to confirm, but this is not required)
- Start broad-spectrum antibiotics
- Admit to ICU/Send to OR

Branch Points

- **IF PERFORATION IS NOT RECOGNIZED CLINICALLY OR BY IMAGING**, then the patient continues to deteriorate despite maximally supportive care. **LACTATE TRENDS UPWARDS, AND PATIENT SUFFERS A CARDIAC ARREST AND DIES**

Required Actions Over the Next Several Minutes

- Examinee should contact ICU physician for admission by this time
- Patient should be admitted to ICU

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CRITICAL ACTIONS

1. Perform early endotracheal intubation

Perform early endotracheal intubation in the management of a patient with a caustic ingestion and the imminent potential for airway edema and compromise.

Cueing Guideline: Nurse can ask if the doctor wants to do anything about the patient's stridor, if endotracheal intubation is deferred initially.

2. Order chest X-ray (CXR)

Order CXR in the management of a patient with a caustic ingestion to help determine if perforation or aspiration has occurred.

Cueing Guideline: The nurse asks if the doctor would like a CXR.

3. Avoid attempts at GI decontamination

GI decontamination with activated charcoal (AC) or whole bowel irrigation (WBI) is ineffective and contraindicated in the context of a caustic ingestion.

Cueing Guideline: The nurse may say, "Are you sure it is appropriate to attempt AC administration or WBI in this patient?"

4. Obtain early GI consultation

Participants should obtain GI consultation early in the management of a patient with a caustic ingestion for possible advanced diagnostics (EGD).

Cueing Guideline: Nurse can ask if the doctor has called the GI consultant yet.

5. Consider perforation when patient deteriorates

When the patient deteriorates in the context of a caustic ingestion, participants should consider perforation as a possible cause (and consult surgery, see below).

Cueing Guideline: Nurse can ask if the doctor can explain why the patient has suddenly deteriorated.

6. Consult Poison Center/Toxicologist

The Poison Center or Toxicology Service should be consulted for further management recommendations.

Cueing Guideline: Nurse can ask if the doctor has called the Poison Center/Toxicologist yet.

7. Administer antibiotics

When the patient deteriorates in the context of a caustic ingestion, participants should consider perforation as a possible cause and administer broad-spectrum antibiotics.

Cueing Guideline: Nurse can ask if the doctor would like to do something if perforation is suspected (and this has been verbalized).

8. Consult Surgery

When the patient deteriorates in the context of a caustic ingestion, participants should consider perforation as a possible cause and consult surgery.

Cueing Guideline: Nurse can ask if the doctor has called the surgical consultant yet.

Critical Actions Checklist¹

Resident Name								
Case Description								
Skills measured <small>Core competencies: PC Patient care, MK Medical knowledge, IC Interpersonal and communication skills, P Professionalism, PB Practice-based learning and improvement, SB Systems-based practice</small>	Very Unacceptable		Unacceptable		Acceptable		Very Acceptable	
Data Acquisition (D) PC MK I	1	2	3	4	5	6	7	8
Problem Solving (S) PC MK PB	1	2	3	4	5	6	7	8
Patient Management (M) PC MK IC P PB SB	1	2	3	4	5	6	7	8
Resource Utilization (R) PC PB SB	1	2	3	4	5	6	7	8
Health Care Provided (H) PC SB	1	2	3	4	5	6	7	8
Interpersonal Relations (I) IC P	1	2	3	4	5	6	7	8
Comprehension of Pathophysiology (P) MK PB	1	2	3	4	5	6	7	8
Clinical Competence (C) PC MK IC P PB SB	1	2	3	4	5	6	7	8
Critical Actions								
Yes	No				Comments:			
		Perform early endotracheal intubation						
		Order CXR						
		Avoid attempts at GI decontamination						
		Obtain early GI consultation						
		Consider perforation when patient deteriorates						
		Consult Poison Center/Toxicologist						
		Administer antibiotics						
		Consult Surgery			Yes	No	Dangerous actions	

¹ Modified ABEM Oral Certification Examination checklist and scoresheet

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STIMULUS INVENTORY

- #1 Complete blood count
- #2 Basic metabolic panel
- #3 Urinalysis
- #4 Liver function tests
- #5 Venous blood gas
- #6 Coagulation studies
- #7 Toxicology
- #8 Radiology (CXR, CT abdomen)
- #9 A: Initial Lactate
B: Repeat Lactate
- #10 ECG

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LAB DATA & IMAGING RESULTS

Stimulus #1	
Complete Blood Count (CBC)	
WBC	18,500/mm ³
Hemoglobin	13.2 g/dL
Hematocrit	40%
Platelets	219,000/mm ³
Differential	
PMNLs	70%
Lymphocytes	26%
Monocytes	2%
Eosinophils	1%

Stimulus #2	
Basic Metabolic Panel (BMP)	
Sodium	145 mEq/L
Potassium	3.6 mEq/L
Chloride	110 mEq/L
Bicarbonate	16 mEq/L
Glucose	129 mg/dL
BUN	17 mg/dL
Creatinine	1.1 mg/dL

Stimulus #3	
Urinalysis	
Color	Yellow
Specific gravity	1.017
Glucose	Negative
Protein	Negative
Ketones	Trace
LE/Nitrites	Negative
Blood	Negative
WBC/RBC	0/hpf / 0/hpf
Crystals/bacteria	Negative

Stimulus #4	
Liver Function Tests	
AST	49 IU/L
ALT	32 IU/L
ALP	110 IU/L
T. Bilirubin	1.2 mg/dL
D. Bilirubin	0.2 mg/dL
Albumin	4.3 mg/dL

Stimulus #5	
Venous Blood Gas	
pH	7.30
pCO ₂	27 mmHg
pO ₂	40 mmHg
HCO ₃ base deficit	16 mEq/L 9
O ₂ Sat	55%

Stimulus #6	
Coagulation Studies	
PT/INR	13.1 seconds / 1.1
PTT	18 seconds

Stimulus #7	
Toxicology	
Salicylate	Undetectable
Acetaminophen	Undetectable
Ethanol	Undetectable
Urine drug screen	
Amphetamines	Negative
Benzodiazepines	Negative
Cocaine	Negative
Opiates	Negative
TCA's	Negative
THC	Negative

Stimulus #8	
Radiology	
Upright CXR	Pneumoperitoneum
CT abdomen	Pneumoperitoneum

Stimulus #9A and #9B	
Lactate	
Initial / Repeat	6.2 / 7.8 mmol/L

Stimulus #10	
ECG Sinus tachycardia. No T wave or ST elevation; No right ventricular strain	

NOTE: A portable supine CXR will not reveal pneumoperitoneum ("free air")

Stimulus #1**Complete Blood Count (CBC)**

WBC	18,500/mm ³
Hemoglobin	13.2 g/dL
Hematocrit	40%
Platelets	219,000/mm ³
Differential	
PMNLs	70%
Lymphocytes	26%
Monocytes	2%
Eosinophils	1%

Stimulus #2**Basic Metabolic Panel (BMP)**

Sodium	145 mEq/L
Potassium	3.6 mEq/L
Chloride	110 mEq/L
Bicarbonate	16 mEq/L
Glucose	129 mg/dL
BUN	17 mg/dL
Creatinine	1.1 mg/dL

Stimulus #3**Urinalysis**

Color / pH	Yellow
Specific gravity	1.017
Glucose	Negative
Protein	Negative
Ketones	Trace
LE/Nitrites	Negative
Blood	Negative
WBC/RBC	0/hpf / 0/hpf
Crystals/bacteria	Negative

Stimulus #4**Liver Function Tests**

AST	49 IU/L
ALT	32 IU/L
ALP	110 IU/L
T. Bilirubin	1.2 mg/dL
D. Bilirubin	0.2 mg/dL
Albumin	4.3 mg/dL

Stimulus #5**Venous Blood Gas**

pH	7.30
pCO ₂	27 mmHg
pO ₂	40 mmHg
HCO ₃ <small>base deficit</small>	16 mEq/L <small>g</small>
O ₂ Sat	55%

Stimulus #6

Coagulation Studies

PT/INR	13.1 seconds / 1.1
PTT	18 seconds

Stimulus #7**Toxicology**

Salicylate	Undetectable
Acetaminophen	Undetectable
Ethanol	Undetectable
Urine drug screen	
Amphetamines	Negative
Benzodiazepines	Negative
Cocaine	Negative
Opiates	Negative
TCA's	Negative
THC	Negative

Stimulus #8

Radiology

Upright CXR	Pneumoperitoneum
CT abdomen	Pneumoperitoneum

Stimulus #9A

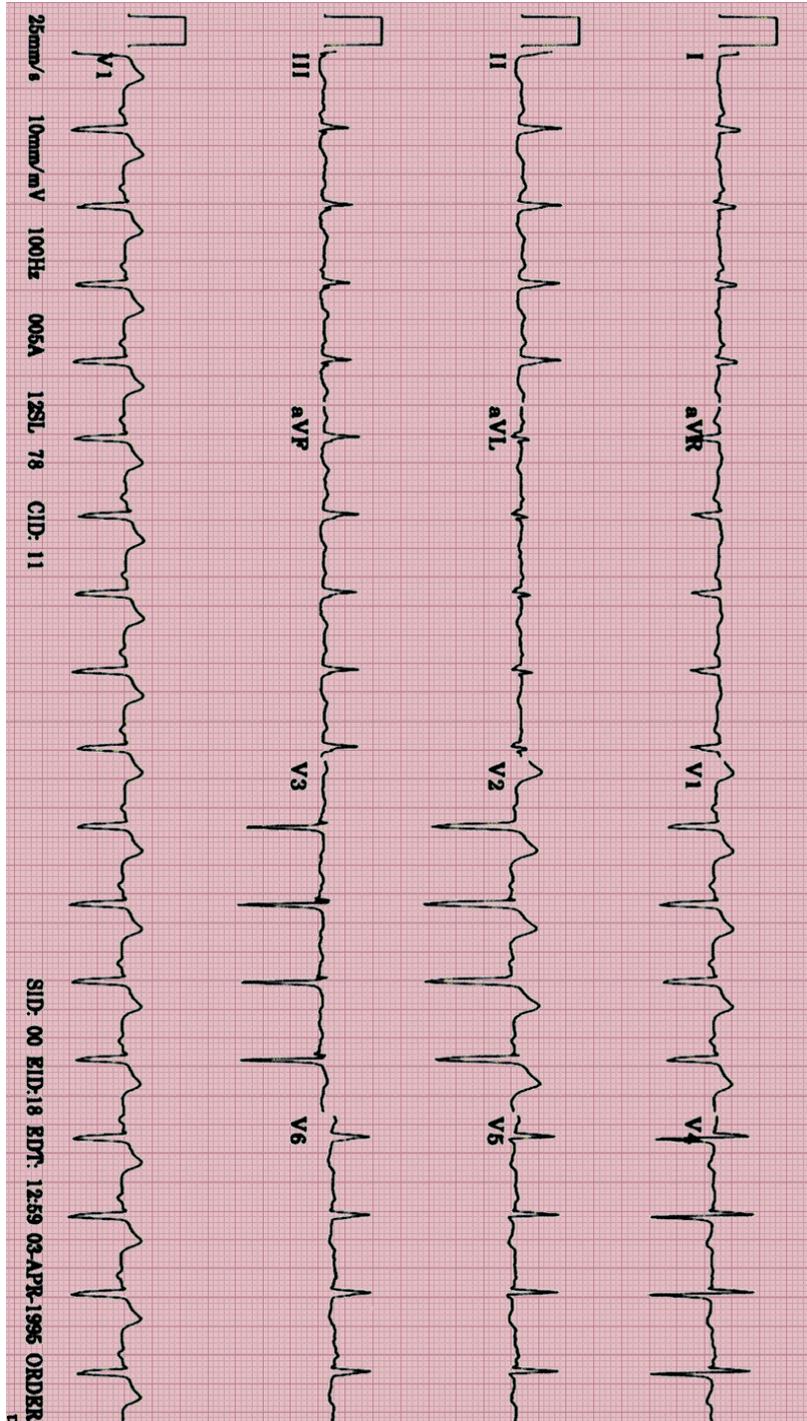
Lactate

Value	6.2 mmol/L
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Stimulus #9B
Repeat Lactate

Value	7.8 mmol/L
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Stimulus #10



Debriefing Materials – Caustic Ingestion

Sources of Exposure:

- Caustic chemicals are commonly found in home and work environments. Their uses include oven cleaners, clogged drain openers, concrete cleaners, automotive detailing, paint stripping, metal or glass etching, and swimming pool treatments to name a few.
- Clinically significant injuries occur from caustics that have a pH < 3 or > 11. However, the concentration, volume, and intent of the ingestion (i.e., accidental versus intentional) contribute to the potential for serious injury.
- Typical household bleach is not usually considered a caustic due to its low concentration, but higher concentrations are available.
- Typical acetic acid (i.e., vinegar) is not a caustic, but highly concentrated solutions are easily purchased and can lead to significant morbidity or death with only small ingestions.

Pathophysiology:

- Caustic chemicals burn the oral and GI mucosa
- Strongly basic chemicals cause liquefactive necrosis leading to deep burns. Basic chemicals tend to cause more injury to the esophagus than to the stomach.
- Strongly acidic chemicals cause coagulative necrosis, may not penetrate as deep as basic chemicals, and may cause injury to both the esophagus and stomach.

Severity of Ingestion:

- Depends on the pH, concentration, and volume of chemical ingested
- The physical exam is often not reliable in excluding severe injury particularly in adult and intentional ingestions
- Prognosis depends on severity of GI injury
- The Zargar modified endoscopic classification of burns is used to predict which patients may have early and late complications such as perforation and stricture formation.
 - Grade 0 – normal examination
 - Grade 1 – edema and hyperemia of the mucosa
 - Grade 2a – friability, hemorrhages, erosions, blisters, whitish membranes, exudates and superficial ulcerations
 - Grade 2b – grade 2a plus deep discrete or circumferential ulceration
 - Grade 3a – multiple ulcerations and small scattered areas of necrosis
 - Grade 3b – extensive areas of necrosis
- Grade 2a or better are associated with minimal early or late complications, whereas grade 2b or higher are associated with a high rate of stricture formation (71% in one series) and perforation.

Organ System Effects:

- Gastrointestinal:
 - Nausea and abdominal pain. May be unable to swallow secretions. Vomiting may occur.
- Pulmonary:
 - Caustic chemicals may be aspirated during attempted ingestion and therefore cause direct lung injury. Coughing and breathlessness may occur.
- Cardiovascular:

- Tachycardia, hypotension, and sometimes chest pain.
- Dermatologic:
 - Erythema and edema of the face, lips, tongue and oral mucosa is possible but the physical exam does not often correlate with the EGD findings. Adults may conceal ingestion by using funnels or hoses to minimize injury to oropharynx.
 - Pediatric patients (<6 years of age) who unintentionally ingest chemicals often stop when they feel pain or encounter a bad taste. Burns may be limited to the lips and/or anterior tongue.

Diagnostic Testing:

- Chemistry panel
 - Repeat as needed
- Chest X-ray
 - Assess for perforation or aspiration
 - Assess endotracheal tube placement
- Obtain hepatic, hematologic, and coagulation profiles for patients with clinical evidence of moderate-to-severe toxicity
- Chest x-ray is indicated if evidence of severe intoxication, pulmonary edema, or hypoxemia is present

Treatment:

- Endotracheal intubation if needed
- Activated Charcoal is not indicated as it does not typically adsorb the caustic substances and it can interfere with EGD staging
- Antibiotics are typically not indicated, as they have not clearly been shown to be beneficial. However, in cases of perforation, broad-spectrum antibiotics are indicated.
- Studies do not show any benefit with steroids as an agent to reduce stricture formation.

Consultations:

- Consult the regional poison center or a local medical toxicologist for additional information and patient care recommendations.
- Consult Gastroenterology for early EGD or surgery if suspected perforation.

Disposition:

- Admit patients with major signs and symptoms to an ICU.
- Unintentional pediatric ingestions may be given a trial of oral intake if oral injury is limited to lips and anterior tongue and they are well appearing. Inability to tolerate secretions, oral intake, or posterior tongue or pharyngeal injury should prompt a GI consultation for EGD.
- Most adult patients with intentional ingestions should be considered for early EGD due to their ability to conceal ingestion by limiting oral injury, and the physical exam does not correlate with EGD findings of esophageal injury.
- Consult psychiatric service personnel for stabilized patients with intentional overdose.

Take-Home Points:

- Caustic chemicals are common in home and work environments
- Ingestions may be accidental or intentional. Unintentional ingestions are more common in pediatric patients < 6 years of age

- Chemicals with pH < 3 or > 11 may cause serious injury but concentration and volume ingested contribute to the potential to cause injury
- The physical exam does not correlate with EGD findings
- Consult the Poison Control Center or Toxicologist for guidance on properties of chemical ingested and appropriate management
- Treatment principles include stabilizing the ABCs, consulting appropriate services, and maintaining a high suspicion for perforation

References:

Zargar SA, Kochhar R, et al. The role of fiberoptic endoscopy in the management of corrosive ingestion and modified endoscopic classification of burns, *Gastrointestinal Endoscopy*, Volume 37, Issue 2, March 1991, Pages 165-169.

Goldfrank, Lewis R. *Goldfrank's Toxicologic Emergencies*. New York: McGraw-Hill Medical Pub. Division, 2002. Tenth Edition. 106.5747-5786. Print.