Caustics

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[Color index : Important | Notes | Extra | Editing file]

Caustics

● **What are Caustics Chemicals** -المواد الكاوية- **?**

- **Chemicals** that cause **tissue injury on contact** with **mucosal** and **epithelial surfaces.**
- Include: **Acids** and **Alkalis.**
- The **severity** of caustic agents typically **increases** with a **pH less than 3** (cause Acidic burns) or **greater than 11** (cause Alkaline burns)**.** (Remember normal PH level is: 7.35 - 7.45) (PH of gastric content: 2-3)
- On the contrary, **hydrofluoric acid (HF)** is a relatively **weak acid** that can cause **necrotizing injury** and **life-threatening systemic toxicity,** (HF burns, not evident until a day after).
- Other chemicals that have caustic properties **Phenol, Formaldehyde, Iodine** and **concentrated hydrogen peroxide.**

Acidic	Alkaline
Acids are **proton donors**, as they **dissociate** into **conjugate bases** and **free hydrogen ions** in solution. ● **Acidic caustics include:** **Hydrochloric acid (HCl)** found in Rust Removal or Toilet bowl cleaner. / **Sulfuric acid (H2SO4)** acidic found in **drain cleaners**	Alkalis **accept protons**, resulting in the formation of **conjugate acids** and **free hydroxide ions**. - Turn Pink Litmus Blues. - **Lye** is an example of an **alkali** and refers to both **sodium hydroxide (NaOH)** and **potassium hydroxide (KOH).** - **Ammonia (NH3)** is another common alkaline corrosive.

Mechanisms of Injury

- **Acidic compounds** desiccate epithelial cells and cause **coagulation necrosis** - An eschar is formed thereby limiting further penetration. - Acids tend to have a **strong odor** and cause immediate pain on contact, the quantity ingested is usually small. - Because of **resistance of squamous epithelium to coagulation necrosis** (from mouth until half of esophagus), acids are thought to be less likely to cause esophageal and pharyngeal injury. - Acids can be **absorbed systemically**, causing **metabolic acidosis**, as well as damage to the spleen, liver, biliary tract, pancreas, and kidneys.	- **Alkaline contact** causes **liquefaction necrosis**, fat saponification, and protein disruption, allowing further penetration of the alkali - The **depth** of the necrosis depends on the **concentration of the alkali.** - A concentration of 30% NaOH in contact with tissue for **1 second** results in a **full-thickness burn** (Transmural). - Alkalis are **colorless, odorless,** and **unlike acids**, do not cause **immediate pain** on contact. - Alkaline **ingestions** typically involve the squamous epithelial cells of the oropharynx, hypopharynx, and esophagus. - The narrow portions of the esophagus (gastric sphincter), where pooling of secretions can occur, are also **commonly involved.** - Alkalis may also cause **gastric necrosis** and **perforation.** - The esophagus can also be **injured**. - **Burns** below the pylorus carry a worse prognosis than burns above the pylorus (50% vs. 9% mortality).

❖ Common Caustics Products

- **Liquid drain cleaners:** have **high concentrations of alkali (30% KOH)** or **acid (93% H2SO4).**
- **Industrial and farms (dairy pipeline) cleaners:**
  - Containing liquid **NaOH** and **KOH (in concentrations of 8–25%).**
- **Swimming pool cleaners** also contain caustics in **high concentrations.** acidic injury

❖ Factors that influence the extent of injury

- **Type of agent** (Acid/Alkali) / **Solid/Liquid** (solids cause more damage and deeper injuries).
- **Concentration of solution** (the more concentrated the solution the deeper and more severe the injury is)
- **Volume** (the more volume the worse is the injury). / **Viscosity** (high viscosity = more severe injury).
- **Duration of contact** (the longer the worse is the injury)
- **pH** (**less than 3** or **greater than 11**).
- **Presence or absence of food in the stomach.** (if you have had a meal it would limit the injury, depending on the amount and type of food)

❖ Accidental Versus Intentional Ingestion:

- **Accidental ingestions** more common in children (Clorox).
- **Intentional ingestions:**
  - Have a greater degree of **oropharyngeal sparing** due to **rapid swallowing.** (presence of oropharyngeal burns doesn't exclude deep burns)
  - Have a higher likelihood of **serious injury.**
  - More than **half** of suicidal patients who **ingest caustic** agents have a history of **psychiatric illness**

❖ Solid Versus Liquid Corrosives:

Solid	Liquid
- **Prolonged tissue adherence:** causing more severe **deep** burns. more pain. - **Crystal drain cleaners** have **lye** concentration as high as **74% NaOH** and may cause **proximal esophageal injury.** - **Ingestion of granular automatic dishwashing detergents** is associated with devastating injuries. - **Anticorrosive cleaners,** such as **31% muriatic acid (HCl),** are sold in gallon containers for home use and as swimming pool cleaners.	- **Less adherence to tissue**, so not serve as much as solids. but more spread! - Takes **less time to split** / Immediate oral pain. - Liquid household bleach typically contains dilute (5.25%) sodium hypochlorite (NaHClO), and ingestion rarely causes injury. - Industrial-strength bleach may contain significantly higher concentrations of **NaHClO** - Toilet bowl cleaners contain **hydrochloric acid** as high as 26%

Household Cleaning Products That Contain Caustic Chemicals:

The doctor did not even read this slide but we put it just in case..

APPLICATION	PRODUCT (MANUFACTURER) CHEMICAL
Drain cleaner—liquid	Heavy Duty Liquid Drain Opener (Share), H_2SO_4 93% Drain Out Extra (Iron Out), KOH 30% Liquid-Plumr (Clorox), NaOH 0.5–2%, NaOCl 5–10% Maximum Strength Drain Opener (Enforcer), KOH 1–10%, NaOCl < 5% Drain Care Professional Strength Drain Opener, NaOH 5–15%
Drain cleaner—crystals	Heavy Duty Crystal Drain Opener (Roebic), NaOH 100% Crystal Drain Opener (Rohyme), NaOH 74% Crystal Drain Out (Iron Out), NaOH 30–60% Drano Pipe Cleaner (Johnson), NaOH 54%
Oven cleaner	Easy Off Heavy Duty Oven Cleaner (Reckitt), NaOH 4–6%
Rust remover	Rust Remover/Carpet Care (Johnson Wax Prof), HCl 10% Rust Stain Remover (Whink), HF 2.5–3% Rust Stripper (Certified), NaOH 50–75% Naval Jelly Rust Remover (Loctite), Phosphoric acid 25–30%
Toilet bowl cleaner	Instant Power Toilet Bowl Cleaner (Scotch), HCl 26% Bowl and Porcelain Cleaner (Cleanline), HCl 0.10% Bowl/Tile/Porcelain Cleaner (Share), Phosphoric acid 15–25% Husky 303 Toilet Bowl Cleaner, HCl 23% Misty Bolex Bowl Cleaner, HCl 26%
Swimming pool cleaner	Muriatic Acid, Aqua Chem (Recreational Water), HCl 31%

❖ Stages of Caustic Injury: at histopathology level

• **Classically**: The damage occurs in following steps: - **Necrosis**. - **Invasion** by bacteria and polymorphonuclear leukocytes. - **Vascular thrombosis** follows, increasing the damage. (the classical inflammation steps)	**Over the next 2 to 5 days:** -Superficial layers of tissue begin to slough. -Healing: The tensile strength of the healing tissue may be quite low for up to 3 weeks increasing chance of delayed perforation. –Between 1 week and several months, granulation tissue forms, collagen is deposited, and re-epithelization	**Esophageal stricture** may form over a period of weeks to years from **contraction of the scar**. can present as dysphagia or acute obstruction -Grade 2A Burns: 15 to 30% develop strictures -Grade 2B: upto 75% develop strictures -Grade 3: 90% result in stricture

❖ Degree of Burn: at clinical level

- **Caustic injury is graded into 3 degrees/Grades** based on **endoscopy**
  - **First:** edema and hyperemia
  - **Second**: superficial ulcers, white membrane, exudates, friability and hemorrhage.
    - Grade 2A: non circumferential (covers only part of the wall, low long term chance of stricture)
    - Grade 2B: Circumferential: (goes all around the surface-deeper-, high long term chance of stricture)
  - **Third:**
    - **Transmural involvement** with deep injury, necrotic mucosa, or frank perforation of the stomach or esophagus.
    - The initial grade of burn on esophagoscopy correlates with the risk of stricture formation.
    - Whether heat from the exothermic reaction increases the injury has never been quantified, but it has led to concerns regarding initial dilution or gastric lavage. (Never dilute an acid with alkaline or vice versa).

❖ CLINICAL FEATURES (depends on the extent of the injury, severity or degree)

- The commonest is : pain at site of contact .
  - **Airway edema** and **esophageal/gastric perforation** are most emergent issues.
  - Laryngeal edema occurs over a matter of minutes to hours.
  - Systemic toxicity; hypovolemic shock; and hemodynamic instability with hypotension, tachycardia, fever, and acidosis are ominous findings.
  - Small ingestion of potent substances can be as serious as larger ingestions.
  - More than 40% of patients reporting to have "only taken a lick" have esophageal burns.
  - Patients present with oral pain (41%), abd pain (34%), vomiting (19%), and drooling (19%).
  - Some have wheezing and coughing. Others present with stridor and dysphonia.
  - **Chest pain** is common. / Symptoms include dysphagia and food impaction..
  - Visible burns to the face, lips & oral cavity. Burns can occur from spills or contamination after vomiting
  - Peritoneal signs suggest hollow viscus perforation or extension of the burn to adjoining visceral areas.
  - **Tracheal necrosis** is one of the **most frequent** causes of death after caustic ingestion.
  - **Oropharyngeal burns** alone do not appear predictive of more distal injury Prolonged drooling and dysphagia predicted significant lesions with 100% sensitivity and 90% specificity. Vomiting and stridor may also be more predictive of burn injury.
  - **Dysphagia** usually subsides in 3 to 4 days. all of they gray colored is in the slides, but dr said its already written above

- Patients with significant esophageal burns, particularly those that are circumferential, may develop esophageal stricture / 80% of strictures become apparent in 2 to 8 weeks.
- Patients have an increase in esophageal cancer (1000-fold to 3000-fold increases) that develops 40 to 50 years after the caustic ingestion.
- A recent long-term study showed that 1.8% of patients who ingested caustic soda developed esophageal cancer.
- Nearly 3% of esophageal cancer patients have a history of caustic ingestion
- Significant acid ingestions may be devastating and result in a higher mortality rate than alkali ingestions.
- The fulminant course of some acid ingestions may be due to systemic absorption of the acid, resulting in **metabolic acidosis** (which may also be the result of extensive tissue necrosis), hemolysis, and renal failure.

❖ DIAGNOSTIC STRATEGIES:

- **History** and **examination**.
- Patients with **chest and abdominal pain should have a chest radiograph and decubitus or upright abdominal studies to identify peritoneal and mediastinal air, denoting perforation or pleural effusion.**
- Any suggestion of abdominal involvement (Perforation), should prompt **abdominal CT or US**.
- **ABG** to monitor systemic metabolic acidosis.
- In cases of intentional overdose, **co-ingestants** should be considered.
- Patients with S&S **(vomiting, drooling, stridor, or dyspnea)** should undergo **endoscopy** within 12 to 24 hours to define the extent of burn.
- Endoscopy is contraindicated in patients with possible or known perforation. also gastric lavage
- The finding of frank necrosis or obliteration of the lumen should result in termination of the procedure.
- Endoscopy performed **too early** may miss the extent or depth of tissue injury.
- Hypoxia warrant immediate **bronchoscopy**.

❖ How to manage the patient ? remember first do ABC, monitor the patient, stop ongoing burning by washing.

- In **alert patients** who are **not vomiting** and can tolerate liquids, small volumes (1–2 cups) of water or milk can be considered within the first few minutes after ingestion. (to dilute not neutralize)
- Early and continuous respiratory and hemodynamic monitoring is essential.
- Contaminated clothing should be treated as hazardous waste and disposed of using proper precautions
- activated charcoal if it was early and small amount of ingested toxin otherwise it is not indicated.
- Careful nasogastric **aspiration** may be useful in the setting of significant acid ingestions presenting immediately after ingestion
- Early **endotracheal intubation** is warranted with airway compromise suggested by hoarseness, throat pain, drooling, or edema.
- Intubation should be **undertaken early** before edema and secretions threaten the airway and make intubation difficult –When oral intubation is anticipated to be difficult awake fiberoptic intubation or primary surgical cricothyrotomy may be necessary
- **IV access and vigorous fluid resuscitation**
- **Surgical exploration is indicated for free air**, peritonitis, increasing and severe chest and abdominal pain, and hypotension.
- Corticosteroid therapy remains controversial.
- Prophylactic antibiotics may potentially mask evidence of impending perforation

❖ Avoid the following:

- Forcing fluids is **never indicated.** / **No Blind nasotracheal intubation**

- Do not neutralize the ingested corrosive with weak acids or alkalis due to thermal reactions and worsening injury.
- Activated charcoal, and performing gastric lavage are not indicated.

❖ **special cases:**

- **Ocular alkali** exposures are true **ophthalmologic emergencies.** - Immediate and aggressive lavage with at least 2 L of normal saline per eye (wash) is indicated in all cases except for frank perforation	- **Dermal caustic exposures** can also result in significant burn injuries. - Clothing removal, copious irrigation, and local wound debridement are the most important initial treatment

- **Hydrofluoric acid:** weak but fluoride is very toxic, monitor cacium level.
  - Although a relatively **weak acid** the dissociated fluoride anions are problematic because of extreme electro-negativity.
  - Deaths from HF exposure have occurred after ingestion, after skin contact in areas as small as 1% BSA with concentrated HF & inhalation of HF vapor.
  - **Systemic toxicity** is characterized by immediate and profound hypocalcemia and dysrhythmias
  - Cardiac and serum calcium monitoring are warranted in all.

• **Povidone-iodine (Betadine):** Used as a surgical scrub and is not a caustic agent, but ingestion of tincture of iodine can cause severe gastrointestinal injury and is potentially life-threatening. Gastric irrigation with starch or milk in these cases may convert iodine to less toxic iodide	• **Concentrated hydrogen peroxide (H_2O_2)** - Ingestion may cause gastrointestinal burn injury and the formation of gas emboli •Radiographic evaluation for the presence of gas in the chest or abdominal cavities, including the portal system, should be performed in symptomatic patients - Hyperbaric oxygen has been used successfully to treat gas emboli from H_2O_2 ingestion.

- **Phenol or Formaldehyde** can also cause severe caustic injury to the gastrointestinal tract
  - Both phenol and formaldehyde are general protoplasmic poisons and can cause protein denaturation and coagulation necrosis.
  - Systemic symptoms, including dysrhythmias, hypotension, seizures, and coma, may result from phenol ingestion.
  - Acidosis may be prominent after formaldehyde ingestion due to its metabolism to formic acid
  - Phenol is well absorbed through the skin, dermal exposure may result in systemic toxicity
  - Dermal decontamination of phenol exposures with LMW polyethylene glycol has been suggested but water may prove just as useful

- **Button batteries** are usually made of a metallic salt (lithium, mercury, nickel, zinc, cadmium, or silver) bathed in NaOH or KOH. (especially in children, they have very toxic metals, when rupture inside GI is very bad)
- Obstruction can cause **pressure necrosis** (magnets), caustic injury due to leakage of alkaline medium,or electrical injury.
- Ulceration, perforation, and possible fistula formation occur but are uncommon.
- Heavy-metal toxicity in this setting has not been reported
- Evaluation requires radiography to assess the position of the foreign body.
- Batteries lodged in the airway or esophagus require expeditious removal.
- Gastric or intestinal batteries can be treated with watchful waiting.
  - Follow-up radiographs should be obtained in 1 week if the battery has not passed.

Summary

Acidic	Alkaline
(proton donors) Hydrochloric acid (HCl) Sulfuric acid (H2SO4)	(accept protons) sodium hydroxide (NaOH)/ potassium hydroxide (KOH). Ammonia (NH3).

Mechanisms of Injury

- **coagulation necrosis** - An eschar is formed . - Cause **immediate pain** on contact.	- **Liquefaction necrosis**/ **full-thickness burn** (Transmural). - **colorless, odorless,** and **unlike acids**, do not cause **immediate pain** on contact.

❖ Factors that influence the extent of injury
- Type of agent (Acid/Alkali)/Solid or Liquid/Concentration/Viscosity/Duration of contact/pH/Presence or absence of food.

❖ **Solid** Versus **Liquid Corrosives:**

Solid	Liquid
- **Prolonged tissue adherence:** causing more severe **deep** burns. more pain.	- **Less adherence to tissue**, so not serve as much as solids. but more spread! - Takes **less time to split** / Immediate oral pain.

❖ **Degree of Burn: Caustic injury is graded into 3 degrees/Grades** based on **endoscopy**
- **First:** edema and hyperemia
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- **Third:** - **Transmural involvement** .

❖ **CLINICAL FEATURES** (depends on the extent of the injury, severity or degree)
- The commonest is : pain at site of contact .
  - Prolonged drooling and dysphagia predicted significant lesions with 100% sensitivity and 90% specificity. Vomiting and stridor may also be more predictive of burn injury./ increase in esophageal cancer

❖ **DIAGNOSTIC STRATEGIES:**
- **Hx** and **Ex** / **chest and abdominal X-ray** / **Endoscopy**
- Endoscopy is contraindicated in patients with possible or known perforation. also gastric lavage

❖ **How to manage the patient ?** remember first do ABC, monitor the patient, stop ongoing burning by washing.
- **Alert patients** + **not vomiting** +tolerate liquids = small volumes (1–2 cups) of water or milk.
- Early and continuous respiratory and hemodynamic monitoring is essential.
- **Endotracheal intubation**
- **IV access and vigorous fluid resuscitation**

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- Activated charcoal, and performing gastric lavage are not indicated.

MCQ's

- While performing upper GI endoscopy for evaluation of caustic ingestion, a physician has to carefully weight the risk of perforation of the esophagus during the producere due to necrosis of burnt mucosal lining of the esophagus and stomach. What is the type of necrosis to be seen in the above patient?
  A- Fibrinous
  B- Liquefaction
  C- Coagulative
  D- Caseuos
  Answer: C
- A 5-year- old child presents with lip and oral burns after accidentally drinking a few sips of drain opening solution. After initial stabilization and pain management an upper GI endoscopy is done. He is noted to have partial thickness circumferential burn involving his esophagus. What are the long-term complications of this finding on endoscopy?
  A- Perforation of esophagus
  B- Bleeding
  C-Esophageal stricture
  D- Mediastinitis
  Answer: C
- A 10-year- old child is brought to your hospital after ingestion of some poison. He is conscious, maintaining his airway and has normal circulation but complains of severe oral pain and inability to swallow. On examination, he has swollen lips, tongue, and drooling of saliva. Which of the following is the likely cause of this presentation?
  A- Caustics
  B-Paracetamol
  C-Aspirin
  D- Pesticides
  Answer: A
- Most lye solutions used as all-purpose cleaners and for industrial purposes contain which one of the following?
  a. Alkaline substance
  b. Acidic solutions
  c. Neutral pH solution
  d. Mixture of acidic and alkaline solution
  Answer: A