

Severe Esophagitis and Chemical Pneumonitis as a Consequence of Dilute Benzalkonium Chloride Ingestion: A Case Report

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Abstract

Background: Benzalkonium chloride (BAC) has been used as an active ingredient in a wide variety of compounds such as surface disinfectants, floor cleaners, pharmaceutical products and sanitizers. Solutions containing <10% concentration of BACs typically do not cause serious injury. As the available data regarding acute BAC toxicity is limited, we report a case of dilute benzalkonium chloride ingestion resulting in bilateral chemical pneumonitis and significant gastrointestinal injury requiring mechanical ventilatory support. **The Case:** A 42-year-old male presented with chief complaints of nausea, vomiting and excessive amount of blood-mixed oral secretions after accidental ingestion of approximately 100ml of BAC solution (<10%). Later he developed respiratory distress with falling oxygen saturation for which he was intubated and mechanical ventilatory support was administered. Computed tomography (CT) chest was suggestive of bilateral chemical pneumonitis and upper gastrointestinal (GI) endoscopy revealed diffuse esophageal ulcerations. The patient was managed with intravenous fluids, corticosteroids, proton pump inhibitor, empiric antibiotics and total parenteral nutrition. **Conclusion:** The present case report emphasizes that dilute BAC compounds can cause severe respiratory and gastrointestinal injuries. Immediate and aggressive medical treatment is crucial for improving patient outcomes and reducing the complication rates.

Key Words: Ammonium Chloride; Benzalkonium Chloride; Esophagitis; Quaternary Ammonium Compounds; Chemical Pneumonitis; Esophageal Ulceration (Source: MeSH-NLM).

Introduction

Benzalkonium chlorides (BACs), reported for the first time in 1935 by Gerhard Domagk, are a class of quaternary ammonium compounds (QACs).¹ Also known as alkyl dimethyl benzyl ammonium chlorides, alkyl dimethyl (phenylmethyl) quaternary ammonium chlorides, ammonium alkyl dimethyl (phenylmethyl) chlorides, or ammonium alkyl dimethyl benzyl chlorides, they are widely used as a mixture of compounds with different alkyl chain lengths in the formulation of disinfectants and bactericidal sanitizers.² Although BACs have been in clinical use for a long period of time, their toxicity is not well established.³ The toxic effects, which can sometimes be fatal, depend on the dose and the route of administration.⁴ Commercially BAC compounds are available in different concentrations depending upon the purpose. Ingestion of BAC can cause local corrosive and systemic effects. Corrosive effects are likely caused by the dissociation of cellular membrane lipid bilayers, leading to cell death from loss of membrane integrity.⁵

Caustic injuries can be categorized as alkaline or acid caustic injuries, however the risk of injury is dependent on the concentration of the solution rather than pH. While lower concentrations (<10%) are not considered to cause significant injury, concentrated solutions (>10%) are known to cause severe upper gastrointestinal and respiratory tract injury.^{6,7}

Highlights:

- Solutions containing <10% concentration of Benzalkonium Chloride (BAC) are generally considered to be of lower risk.
- In this case report, we describe that dilute BAC compounds can potentially lead to serious gastrointestinal and respiratory injury.
- The modality of treatment vary from supportive therapy to emergency surgical intervention.

We describe a case in which ingestion of a relatively dilute solution of BAC resulted in considerable injury to the upper gastrointestinal tract and bilateral chemical pneumonitis requiring mechanical ventilatory support. As the available data regarding BAC ingestion and the resultant toxicity are limited, this case report presents a brief assessment of the clinical management of BAC toxicity and aims to provide a strategy for managing similar situations. Informed consent of publication was obtained from the patient.

The Case

A 42-year-old male presented to emergency department after accidental ingestion of approximately 100ml of BAC solution under inebriated condition two hours ago. The solution consisted of alkyl dimethyl

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Editor: Francisco J. Bonilla-Escobar

Student Editors: Diego Carrion Alvarez &

Johnmark Boachie

Copyeditor: Nikoleta Tellios

Proofreader: Benjamin Liu

Layout Editor: Francisco J. Bonilla-Escobar

Submission: Mar 5, 2021

Revisions required: Mar 5; Apr 9; Aug 3, 2021

Received in revised form: Mar 7; Jul 10; Aug 10, 2021

Acceptance: Aug 10, 2021

Publication: Aug 12, 2020

Process: Peer-reviewed

benzyl ammonium chloride (<10%) and didecyl dimethyl ammonium chloride (<10%) being used for surface disinfection. Patient complained of nausea, abdominal pain, and hematemesis with copious amount of blood-mixed frothy sputum. He also complained of itching all over the body.

On initial clinical examination, he was found to be conscious and oriented to time, place and person. BP was 140/90mmHg with a pulse rate of 104/min, SpO₂ 97% on room air, and respiratory rate of 16/min. Chest was clear on auscultation with bilateral vesicular breath sounds without any adventitious sound. Cardiac examination demonstrated normal heart sounds, but mild tachycardia. Abdominal examination was notable for mild epigastric tenderness without guarding or rebound. The neurological examination was grossly intact without any focal deficit.

His initial laboratory analysis demonstrated normal hemoglobin (13.7 g/dl) and platelets (1.6 lac/cumm). TLC was 8100/cumm with relative neutrophilic predominance (90.8%). Liver function test, renal function test, serum electrolytes, random blood sugar, arterial blood gas analysis and serum lactate levels were within normal limits. Chest and abdominal X-rays and ECG revealed no abnormality.

Patient was shifted to medical intensive care unit for close monitoring and was managed with intravenous fluids, anti-emetics, dexamethasone and a proton pump inhibitor. However, after an hour of initial stabilization, the patient's condition began to deteriorate with worsening respiratory distress and SpO₂ dipping to 70% (on room air). In view of excessive blood mixed oral secretions and falling oxygen saturation, patient was intubated and mechanical ventilatory support was administered.

Laryngoscopic examination revealed diffuse erythema and sloughing of mucosa in the oropharynx. Laryngeal edema was also evident. CT scan of the chest was done next day which demonstrated bilateral diffuse ground-glass opacities and bilateral pleural effusion with underlying atelectasis on right side as depicted in **Figure 1**. There was no evidence of any honeycombing or emphysema. RT-PCR for COVID-19 was negative.

Upper GI endoscopy was performed which revealed diffuse mucosal sloughing and ulcerations in the esophagus, suggestive of severe esophagitis with mild gastritis as shown in **Figure 2**. The patient was managed with empiric antibiotics, IV steroid therapy, a proton pump inhibitor and parenteral nutrition. During the ICU stay, patient maintained his vitals without any significant derangement of renal and liver functions and his condition improved with the treatment. He was gradually weaned off and extubated successfully on the 8th day of admission. Gradually he resumed oral intake, first with clear liquid and then advanced to a low-fat, low-fiber diet, which was well tolerated. On day 14, the patient was discharged under stable condition. At the one-month follow-up visit, the patient was doing well without any significant gastro-intestinal and respiratory complication, or sequelae.

Discussion

Ingestion of both acid and alkali has a wide variety of initial presentations and severities, as well as later complications. The formulation ingested by the patient in the present report contained dual quaternary ammonium compounds i.e., alkyl dimethyl benzyl ammonium chloride (<10%) and didecyl dimethyl ammonium chloride (<10%). BAC is a cationic detergent that is not typically known for having strong corrosive qualities. Lower concentrations of BAC are generally considered to be of lower risk. Severe caustic injury due to BAC appears to be associated with solutions of concentration greater than 10%. In lower concentrations, BAC may produce a hypersensitivity type of reaction, and this has been suggested to be evidence of the irritant properties.⁸

Figure 1. CT Chest Image Showing Bilateral Ground-Glass Opacities

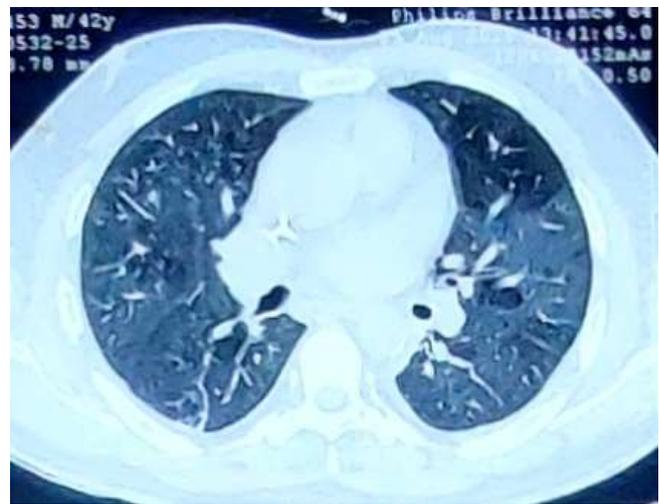
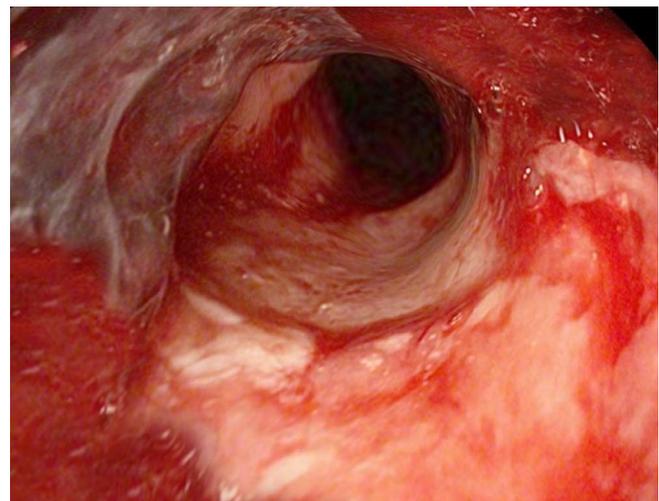


Figure 2. Upper GI Endoscopy Showing Diffuse Esophageal Ulcerations



The effects after ingestion of BAC appear to be due to caustic gastrointestinal tract injury and airway involvement causing tracheo-bronchitis and chemical pneumonitis. Clinical features include nausea, vomiting, dysphagia, dyspnea, corrosive injuries to the gastrointestinal tract, transaminase elevations, metabolic acidosis, renal failure and central nervous system depression. Neuromuscular paralysis can also occur due to cholinesterase inhibition at the neuromuscular junction.⁴ In the present report, the patient had developed nausea, vomiting, esophagitis and chemical pneumonitis after ingestion of BAC. The patient had also consumed alcohol prior to BAC ingestion. Although alcohol can cause erosive esophagitis in the long term, severe ulcerative esophagitis as observed in our patient was less likely to be caused by alcohol. Further, the patient was a chronic alcoholic and his acute condition could not be attributed only to intake of alcohol. Spiller HA (2014) reported a case in which the patient had developed significant gastro-esophageal and tracheo-bronchial injury following ingestion of a BAC solution.⁹ In another case reported by Kulbay H et al (2014), the patient was found to have multiple lesions in the esophagus and stomach caused due to accidental ingestion of a BAC compound.¹⁰ However, in both of these reported cases, the patients had consumed highly concentrated BAC solution (10%) whereas in the present report, the BAC solution was of lower concentration (<10%).

Endoscopy is important for evaluation of the extent and severity of gastrointestinal tract injuries. However there has been controversy regarding the ideal timing to perform it. Some experts recommend urgent endoscopy while others have suggested waiting for some time so as to determine the full extent of injury.^{11,12} There are four endoscopic grades of caustic injury: Grade 1, edema and erythema; Grade 2 (2a linear, 2b circumferential) hemorrhages, erosions, blisters, superficial ulcers, and exudates; Grade 3, multiple deep brownish-black or gray ulcers; Grade 4, perforation.¹¹⁻¹³ In the present case, upper GI endoscopy revealed grade 2 injury in the esophagus with mild gastritis. Other conditions causing esophageal ulcerations include gastroesophageal reflux, infections such as candida species, herpes simplex, cytomegalovirus, drugs such as NSAIDs, bisphosphonates, some antibiotics, alcohol and esophageal carcinoma.^{14,15} However, in the context of history of ingestion of a BAC compound with acute nature of the injuries in the form of diffuse mucosal sloughing and ulcerations with erythema in the esophagus, oropharynx and larynx, other causes seemed to be unlikely.

Chemical pneumonitis, as was present in our patient, can also be seen with BAC ingestion. It can be caused by aspiration of the caustic compound, through necrotic extension from an extensively injured upper gastrointestinal tract, or through involvement of the mediastinum. Pulmonary edema may also accompany chemical pneumonitis. COVID-19 infection can also cause similar lung picture of diffuse ground-glass opacities on CT imaging, but the interpretation of the CT findings has to be combined with the clinical features and in our case, clinical signs and symptoms were not consistent with COVID-19 infection and RT-PCR was negative.

Prognosis depends upon the ingested dose consumed and time to treatment initiation. Treatment depends on the patient's clinical

condition, the severity of toxicity, and the complications. Treatment includes aggressive therapy with stringent monitoring as well as emergency surgical intervention, if required, in the case of complications. The treatment goal is to prevent perforation and stricture formation. The role of corticosteroids has not been well established yet and is controversial. However, there is supportive evidence that corticosteroids can reduce the formation of stricture in grade 2 injuries.¹⁶ Empiric antibiotics were administered to our patient in view of risk of secondary bacterial infection. However, there are no human studies supporting the routine use of antibiotics.

The delayed gastrointestinal complications of caustic ingestions include esophageal stricture and stenosis, antral stenosis, carcinoma of the esophagus and stomach. The rate of stricture formation is dependent on the severity and degree of injury, with around one third of patients with second and third-degree burns developing strictures.¹⁷ Other late complications comprises of tracheal stenosis, tracheo-bronchial fistula and gastro-colic fistulization.

Conclusion

Although generally less frequently encountered, dilute BAC compounds can potentially cause serious injuries to the gastrointestinal and respiratory systems. Treatment strategies should primarily focus on hemodynamic and airway management. Endoscopy should be performed to evaluate the extent of injury. A gastroenterologist and a surgeon should be involved in potentially seriously injured cases. We report here a case of accidental ingestion of dilute BAC solution causing bilateral chemical pneumonitis and gastro-esophageal injury.

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Acknowledgments

None.

Conflict of Interest Statement & Funding

The Authors have no funding, financial relationships or conflicts of interest to disclose.

Author Contributions

Conceptualization, Data Curation, Investigation, Methodology, Project Administration, Supervision, & Visualization: AK & RC. Resources: AK, RC, ST. Writing – Original Draft Preparation & Writing – Review & Editing: AK, RC, PR, ST, SG, RP, MV, SG, AA.

Cite as

Kumar A, Chetiwal R, Rastogi P, Tanwar S, Gupta S, Patnaik R, et al. Severe Esophagitis and Chemical Pneumonitis as a Consequence of Dilute Benzalkonium Chloride Ingestion: A Case Report. Int J Med Students. 2021 Jul-Sep;9(3):231-4.

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ISSN 2076-6327

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