

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

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Contributor Role	Role Definition	Authors								
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Conceptualization	Ideas; formulation or evolution of overarching research goals and aims.	X	X							
Data Curation	Management activities to annotate (produce metadata), scrub data and maintain research data (including software code, where it is necessary for interpreting the data itself) for initial use and later reuse.	X	X							
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Highlights:

3

- Solutions containing <10% concentration of Benzalkonium Chloride (BAC) are generally considered to be of lower risk.

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- In this case report, we describe that dilute BAC compounds can potentially lead to serious gastrointestinal and respiratory injury.

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- The modality of treatment vary from supportive therapy to emergency surgical intervention.

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Discussion Points

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1. Benzalkonium Chloride is used in wide variety of compounds ranging from disinfectant solutions to medical compounds.

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2. A relatively dilute BAC solution which is generally considered safe can lead to severe toxicity, both local and systemic.

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3. Prompt recognition of signs and symptoms and institution of early aggressive treatment can be life saving and prevents development of long term complications.

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1 **ABSTRACT.**

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3 **Background:** Benzalkonium chloride (BAC) has been used as an active ingredient in a wide variety of
4 compounds such as surface disinfectants, floor cleaners, pharmaceutical products and sanitizers. Solutions
5 containing <10% concentration of BACs typically do not cause serious injury. As the available data regarding
6 acute BAC toxicity is limited, we report a case of dilute benzalkonium chloride ingestion resulting in bilateral
7 chemical pneumonitis and significant gastrointestinal injury requiring mechanical ventilatory support.

8

9 **The Case:** A 42 year old male presented with complaints of nausea, vomiting and excessive amount of blood
10 mixed oral secretions after accidental ingestion of approximately 100ml of BAC solution (<10%). Later he
11 developed respiratory distress with falling oxygen saturation for which he was intubated and mechanical
12 ventilatory support was administered. Computed tomography (CT) chest was suggestive of bilateral chemical
13 pneumonitis and upper gastrointestinal (GI) endoscopy revealed diffuse esophageal ulcerations. The patient
14 was managed with intravenous fluids, corticosteroids, proton pump inhibitor, empiric antibiotics and total
15 parenteral nutrition.

16

17 **Conclusion:** The present case report emphasize that dilute BAC compounds can cause severe respiratory
18 and gastrointestinal injuries. Immediate and aggressive medical treatment is crucial for improving the patient
19 outcomes and reducing the complication rates.

20

21 **Key Words:** Ammonium chloride; Benzalkonium chloride; Esophagitis; Quaternary ammonium compounds;
22 chemical pneumonitis; esophageal ulceration (Source: MeSH-NLM).

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24

1 **INTRODUCTION**

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

14

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

19

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

25

1 THE CASE

2

3 A 42-year-old male presented to emergency department with accidental ingestion of approximately 100ml of
4 BAC solution under inebriated condition two hours ago. The solution consisted of alkyl dimethyl benzyl
5 ammonium chloride (<10%) and didecyl dimethyl ammonium chloride (<10%) being used for surface
6 disinfection. Patient complained of nausea, pain abdomen and vomiting (bloody) with copious amount of blood
7 mixed frothy sputum. He also complained of itching all over the body.

8

9 On initial clinical examination, he was found to be conscious and oriented to time, place and person but
10 irritable, BP was 140/90mmHg with a pulse rate 104/min, SpO₂ 97% on room air, and respiratory rate of
11 16/min. Chest was clear on auscultation with bilateral vesicular breath sounds without any adventitious sound.
12 Cardiac examination demonstrated normal heart sounds, but mild tachycardia. Abdominal examination was
13 notable for mild epigastric tenderness without guarding or rebound. The neurological examination was grossly
14 intact without any focal deficit.

15

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

20

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

26

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

32

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

42

1 DISCUSSION

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3 Ingestion of both acid and alkali can result in wide variety of presentation, severity and complication. The
4 formulation ingested by the patient in present report contained dual quaternary ammonium compounds i.e,
5 alkyl dimethyl benzyl ammonium chloride (<10%) and didecyl dimethyl ammonium chloride (<10%). BAC is a
6 cationic detergent that is usually not known to have severe irritant properties. Lower concentrations of BAC
7 are generally considered to be of lower risk. Severe caustic injury due to BAC appears to be associated with
8 solutions of concentration greater than 10%. In lower concentrations BAC may produce a hypersensitivity type
9 of reaction and this has been suggested to be evidence of the irritant properties.⁸

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

25
26 Endoscopy is important for evaluation of the extent and severity of gastrointestinal tract injuries. However
27 there has been controversy regarding the ideal timing to perform it. Some experts recommend to perform it
28 urgently while others have suggested waiting for some time so as to determine the full extent of injury.^{11,12}
29 There are four endoscopic grades of caustic injury: Grade 1, edema and erythema; Grade 2 (2a linear, 2b
30 circumferential) hemorrhages, erosions, blisters, superficial ulcers, and exudates; Grade 3, multiple deep
31 brownish-black or gray ulcers; Grade 4, perforation.¹¹⁻¹³ In the present case, upper GI endoscopy revealed
32 grade 2 injury in the esophagus with mild gastritis. Other conditions causing esophageal ulcerations include
33 gastroesophageal reflux, infections such as candida species, herpes simplex, cytomegalovirus, drugs such as
34 NSAIDs, bisphosphonates, some antibiotics, alcohol and esophageal carcinoma.^{14,15} However, in the context
35 of history of ingestion of a BAC compound with acute nature of the injuries in the form of diffuse mucosal
36 sloughing and ulcerations with erythema in the esophagus, oropharynx and larynx, other causes seemed to
37 be unlikely.

38
39 Chemical pneumonitis, as was present in our patient, can also be seen with BAC ingestion. It can be caused
40 by aspiration of the caustic compound, through necrotic extension from an extensively injured upper
41 gastrointestinal tract, or through involvement of the mediastinum. Pulmonary edema may also accompany

1 chemical pneumonitis. Covid-19 infection can also cause similar lung picture of diffuse ground glass opacities
2 on CT imaging, but the interpretation of the CT findings has to be combined with the clinical features and in
3 our case, clinical signs and symptoms were not consistent with covid-19 infection and RT-PCR was also
4 negative.

5
6 Prognosis depends upon the dose and time of initiation of the treatment. Treatment depends on the patient's
7 clinical condition, severity of toxicity and complications. Treatment includes aggressive therapy with stringent
8 monitoring as well as the emergency surgical intervention, if required, in case of development of complication.
9 The treatment goal is to prevent perforation and stricture formation. The role of corticosteroids has not been
10 well established yet and is controversial. However, there is supportive evidence that corticosteroids can
11 reduce the formation of stricture in grade 2 injuries.¹⁶ Empiric antibiotics were administered to our patient in
12 view of risk of secondary bacterial infection. However, there are no human studies supporting the routine use
13 of antibiotics.

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

19

20 **Conclusion**

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

26

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- 34

1 **FIGURES AND TABLES.**

2

3 **Figure 1. CT Chest Image Showing Bilateral Groundglass Opacities**

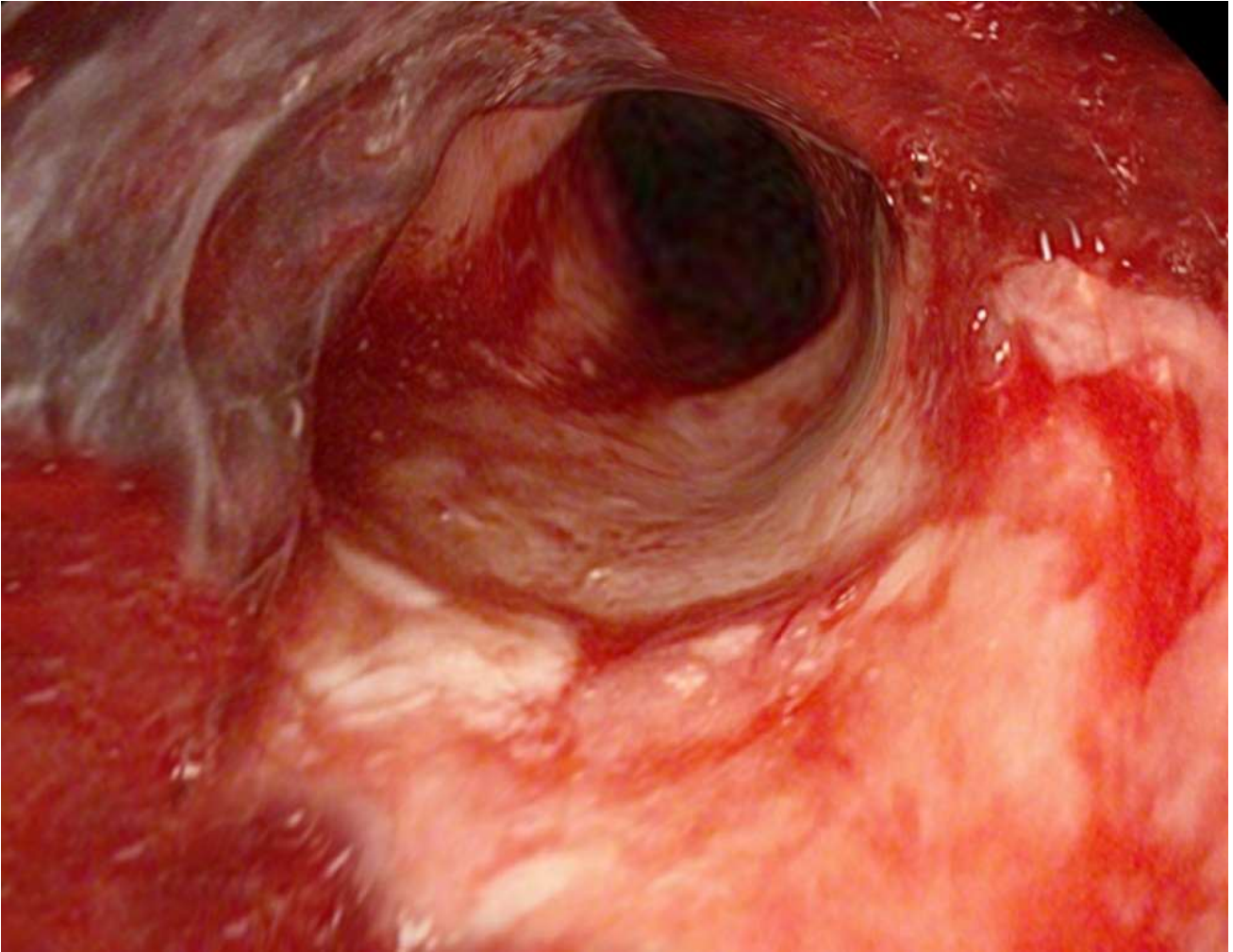
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1 **Figure 2.** Upper GI Endoscopy Showing Diffuse Esophageal Ulcerations

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Accepted