Caustic material ingestion: A five-year experience in a tertiary Toxicology Referral Center

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Abstract

Significance: Global epidemiologic data on caustic material ingestion (CMI) are scarce because of underreporting; yet it remains to be an important public health problem. *Methodology:* This is a retrospective cross-sectional study of adult patients admitted at the University of the Philippines-Philippine General Hospital (UP-PGH) for caustic ingestion from January 2013 to June 2018 which aims to determine incidence of caustic ingestion and clinico-demographic profile of patients. Severity of mucosal injury is mapped against the intervention done. In-patient mortality and surgery rates are determined. *Results:* This study shows that there were 80 caustic ingestion admissions per year at this institution from January 2013 to June 2018. A total of 399 admitted CMI cases were included, with 199 males (49.87%) and 200 females (50.13%), having a mean age of 32.67±13.14. Intentional ingestion is seen in majority of cases (n=332, 83.42%). Mortality is low (2%) and mostly related to acidic substance ingestion. Deaths are attributed to hospital acquired infection post-surgery. Acid ingestion cases have higher mortality (80%) than alkali ingestion. Injury to the esophagus is mostly 2A (36.4%). The most severely affected area of the stomach is the fundus at 42% (3A and 3B injuries). Surgical rate is 7%. Surgery showed that 92% of cases had 3B injuries to the cardia, fundus and body. *Conclusion:* Endoscopic evaluation is recommended. Assessment of severity of injury by Zargar classification is an important guide in the management of cases and imperative in decision making.

Keywords: retrospective, caustic ingestion, Zargar Classification

Epidemiologic data for caustic material ingestion (CMI) worldwide are scarce because of underreporting. Its true prevalence simply cannot be extrapolated from random articles or personal experience.[1,2] It remains an important public health problem[3] and its incidence, especially in low-income countries, has been increasing due to a lack of effective regulatory measures and public health prevention programs.

The extent of the injury caused by caustic ingestion is determined by a number of factors including the nature of the agent, the amount consumed, the concentration, and the length of time the agent was in contact with a given tissue.[2] This can range from respiratory tract involvement manifesting as hoarseness, stridor or dyspnea to dysphagia, odynophagia, epigastric pain or an acute abdomen due to gastric perforations requiring immediate surgical management.

In patients with intentional caustic ingestion, mortality is high. Several risk factors for mortality according to previous studies include age, male gender, acid and detergent ingestion, leukocytosis, gastric ulcers and necrosis, and suicidal intent.[4-8] Recently, the presence of a psychiatric condition was found to be associated with poorer outcomes.[9] In a study by Libuit et al. on predictors of mortality in caustic ingestion in patients from 2008 to 2012 at the University of the Philippines-Philippine General Hospital (UP-PGH), metabolic acidosis, presence of psychiatric disorder, perforation and those needing surgery were associated

with increased risk of mortality.[10] In Libuit's study, mortality rate among 303 adult cases was 8.1%.

Endoscopy is considered a cornerstone in the diagnosis of CMI. Discrepancies between endoscopic findings and the extent of necrosis found intra-operatively suggest the need for better criteria to improve patient selection for emergency surgery.[11] Timely surgery is important for those sustaining severe injuries and an aggressive approach should be considered in such patients to avoid further damage and complications.

At the UP-PGH where this study was conducted, a team composed of the institution's emergency medicine physicians, toxicologists, psychiatrists, and experts from the Gastroenterology Section and Surgery Department allows a multi-disciplinary approach in management.

International and local studies alike are deficient in presenting the true prevalence rates and consensus on the management of cases. Most countries have limited experience in managing caustic injury and only institution-based guidelines exist.

This study aims to describe the demographic profile, clinical and endoscopic findings, complications, management and outcomes of caustic ingestion. The UP-PGH is a mine field for a study in this area, since it is where the National Poison Management and Control Center (NPMCC) operates under the Department of Toxicology. This Center is considered as the country's primary referral center for toxicology cases. One of the common referrals they get is ingestion of caustic material, which is the second leading indication for endoscopy in this institution, second only to upper gastrointestinal bleeding.

Studies done on caustic ingestion may be used to assess trends, weigh the true burden of the problem, and perhaps in the future help formulate a set of guidelines for patient management.

Methodology

This is a retrospective cross-sectional study done from January 2013 to June 2018 on caustic ingestion patients aged 19 and above who were seen at the Emergency Room of the UP-PGH. Only patients who were admitted for acute CMI were included.

Exclusion criteria included the following: (1) those presenting with late sequelae such as stricture formation; (2) presenting with hospital acquired infections; and (3) incomplete data from the database.

Operational Definition

A *caustic material* is a known acid or alkaline substance having a pH of <2 and >12, respectively, causing mucosal injury. Known corrosives with indeterminate acid or basic nature are included.

Data Collection

Data were gathered from the institution's toxicology database, the Integrated Surgical Information System (ISIS) computer database of the Department of Surgery, as well as from the endoscopy database of the Section of Gastroenterology.

Database review was done solely by the principal investigator who extracted the following information using a standardized case report form: age, sex, ingested agent (classified based on pH), intent (accidental, non-accidental), presenting symptoms and vital signs, time to initial consult (hours from ingestion), laboratory values (arterial pH, base deficit, creatinine, white cell count, platelet count, imaging), endoscopic findings (based on Zargar classification), management (diagnostic and therapeutic), surgical procedure done, and outcomes (mortality, morbidity, surgical intervention). The severity of mucosal injury was graded based on Zargar's modified endoscopic classification. There were no third party research assistants in this study.

Data was encoded directly to a Microsoft Excel worksheet. For confidentiality, patient data was anonymized by coding. No names or case numbers were extracted. Data encoded in the Excel file was saved on a single password-protected computer, accessible only by the principal investigator and co-investigators. Data gathered will be stored until five years from completion of the research or until publication, whichever comes first, after which the main Excel worksheet will be deleted.

Ethical Considerations

In accordance with National Guidelines, waiver for informed consent was requested by the principal investigator, the study being a review of existing database maintaining anonymity at all times therefore deemed non-sensitive. The protocol was approved by

the University of the Philippines Manila Research Ethics Board (UPMREB). To ensure confidentiality, number codes were assigned to cases. No other information was obtained aside from the data needed. The study complied with the Data Privacy Act of the Philippines. In cases of breach of privacy, where none was encountered, the matter was to be forwarded to the PGH Data Privacy Officer.

Statistical Analysis

Data was encoded in a pre-made Microsoft Excel 2016 worksheet. Data cleaning prior to data analysis was done by checking for miscoded data, missing values, and inconsistencies. Descriptive statistics were used to summarize demographic and clinical characteristics. Frequency and percentage were used for qualitative data, while mean ± standard deviation was used for quantitative variables. The associations of baseline, clinical, and laboratory variables with endoscopic grade of severity and mortality were estimated using appropriate statistical tests such as Chi-square and Fisher's exact t-test. The level of significance was at $p < 0.05$.

Results

A total of 399 cases of acute caustic ingestion over a five-year period were included in this study. Patient characteristics and clinico-demographic profile are summarized in **Table 1**. The mean age of patients is 32.67 ± 13.14, with an almost equal distribution between males 199 (49.87%) and females 200 (50.13%). Majority of patients (252/399) are unmarried. There are 332 cases of intentional or deliberate ingestion (83.42%) compared to 66 cases of accidental or non-deliberate ingestion (16.58%). Forty percent of patients have psychiatric disorder diagnosis, with a majority diagnosed of having just an adjustment disorder, followed by major depressive disorder, then bipolar disorder. Time to consult averages four hours with a range of two to eight hours. The patients' average length of stay is two days. Prolonged stay is attributed to morbid cases such as those who underwent surgery or had complications that developed during their perioperative period, such as pneumonia or sepsis.

Table 1. Demographic profile of cases (n = 399)

Age	32.67 ± 13.14
Sex	
Male	199 (49.87)
Female	200 (50.13)
Marital Status	
Single	252 (63.16)
Married	132 (33.08)
Widowed	9 (2.26)
Separated	6 (1.50)
Length of hospital stay	
Days	2 (2–5)
Amount ingested (ml)	50 (30–100)
Intent of ingestion	
Intentional	332 (83.42)
Accidental	66 (16.58)
Psychiatric disorder	103 (40.55)
Time to consult (hours)	4 (2-8)

The most common presenting symptoms are vomiting (76.92%), abdominal pain (51.13%) and throat pain (35.29%), with 88 cases of abdominal tenderness. Three cases presented with guarding at the emergency room and these were those who had gut perforations and underwent immediate surgery. Majority of the patients have leucocytosis (**Table 2**).

Table 2. Presenting symptoms and PE of cases (n = 399)

Presenting symptoms	n (%)
Vomiting	170 (76.92)
Abdominal pain	113 (51.13)
Throat pain	78 (35.29)
Dysphagia	46 (20.81)
Dyspnea	36 (16.36)
UGIB	31 (14.09)
Initial vital signs	
Systolic BP	117.43 ± 17.50
Diastolic BP	75.40 ± 13.08
Heart Rate	93.75 ± 18.93
Respiratory Rate	21.08 ± 6.89
Physical exam	
Abdominal tenderness	88 (40.0)
Guarding	3 (1.37)
Others	61 (27.85)
Laboratory findings	
ABG pH	7.45 (7.42-7.48)
ABG HCO3	19.8 (17.2-22)
ABG pCO2	28.3 (25.3-31.7)
Creatinine (mg/dL)	68 (54-83)
Hemoglobin (g/L)	143 (133.5-156)
Hematocrit	0.43 (0.40-0.47)
WBC (per mm^3)	11.86 (9.25-7.25)
Platelet count (per µL)	282.5 (235-332)

Outcomes show five cases of mortality, two due to septic shock, another two due to acute respiratory failure, and one died of multi-organ failure. Seven percent of the patients went home against medical advice and the rest were discharged improved.

Substance Ingested

As shown in **Table 3**, there are more cases of alkali ingestion (n=255, 64%) than that of acids (n=144, 36%), which do not have any significant difference. Average ingestion amount for all cases is 50 ml. Accidental ingestion is higher among those with alkali ingestion having 41 cases as compared to 25 cases among those who took an acidic substance. This might be because of the readily available alkaline substances that are used at home and in the workplace, such as cleaners and bleach.

Table 3. Comparison of caustic-related factors to type of substance ingested

	Total (n = 399)	**Acid (n = 144)**	**Alkali (n = 255)**	*P* value
	Frequency (%); Mean ± SD; Median (IQR)			
Amount (ml)	50 (30-100)	50 (30-100)	50 (30-100)	0.561
pH of substance	9 (3-11)	3 (3-3)	11 (11-11)	**<0.001**
Intent of ingestion				0.753
Intentional	332 (83.42)	119 (82.64)	213 (83.86)	
Accidental	66 (16.58)	25 (17.36)	41 (16.14)	
Time to consult (hours)	4 (2-8)	5 (3-9)	3.75 (2-6)	**0.036**

The most common alkaline substance is sodium hypochlorite (47.12%) while hydrochloric acid (26.07%) is the most common acid. The frequencies of the other substances are shown below **(Table 4)**.

Table 4. Caustic substances used (n = 399)

Substance Used	**n (%)**
Sodium hypochlorite	118 (47.12)
Muriatic acid	104 (26.07)
Silver jewelry cleaner	51 (12.78)
Oxalic acid	12 (3.01)
Toilet cleaner	10 (2.51)
Others	34 (8.52)

Table 5 shows the type of caustic substance and clinical presentation. Among patients who died, four out of five ingested an acidic substance. These were all from intentional hydrochloric acid ingestion who presented with poor clinical parameters such as guarding, hypotension, metabolic acidosis; three underwent surgery and expired from hospital-acquired infections, while one had refractory shock at the outset.

Dyspnea is more commonly seen in alkali ingestion with statistical significance, while upper gastrointestinal bleeding is more common among those who ingested acidic material.

Table 5. Type of caustic substance, clinical presentation and findings

	Total (n=399)	**Acid (n=144)**	**Alkali (n=255)**	***P*-value**
	Frequency (%); Mean ± SD; Median (IQR)			
Outcome				**0.011**
Discharged	347 (86.97)	126 (87.50)	221 (86.67)	
Mortality	5 (1.25)	4 (2.78)	1 (0.39)	
HAMA/Absconded	30 (7.52)	5 (3.47)	25 (9.80)	
Presenting symptoms				

Initial vital signs				
Systolic BP	117.43 ± 17.50	119.28 ± 19.33	116.59 ± 16.60	0.297
Diastolic BP	75.40 ± 13.08	74.84 ± 12.70	75.66 ± 13.28	0.670
Heart rate	93.75 ± 18.93	91.54 ± 20.42	94.75 ± 18.20	0.249
Respiratory rate	21.08 ± 6.89	20.72 ± 5.34	21.25 ± 7.49	0.601
Physical exam				
Abdominal tenderness	88 (40.00)	42 (58.33)	4 (31.08)	**<0.001**
Guarding	3 (1.37)	3 (4.23)	0	**0.012**
Others	61 (27.85)	22 (30.99)	39 (26.35)	0.474
Laboratory findings				
ABG pH	7.45 (7.42–7.48)	7.44 (7.40–7.47)	7.46 (7.43–7.49)	**0.024**
ABG HCO3	19.8 (17.2–22)	19.1 (16.2–21.35)	20 (17.8–22)	0.142
ABG pCO2	28.3 (25.3–31.7)	28.1 (25.4–31)	28.6 (25.8–32.6)	0.372
Creatinine	68 (54–83)	71.5 (57.5–90.5)	63.5 (52–79)	**0.006**
Hemoglobin	143 (133.5–156)	145 (132–163)	143 (134–151)	0.157
Hematocrit	0.43 (0.40–0.47)	0.44 (0.40–0.49)	0.43 (0.41–0.46)	0.289
WBC	11.86 (9.2517.25)	15.68 (11.6320)	10.6 (8. 5–15)	**<0.001**
Platelet count	282.5 (235–332)	255 (205–317)	298 (255–353)	**<0.001**

There is no statistical significance among the types of caustic substance in terms of the patient's initial vital signs. However, laboratory values show that initial arterial pH, creatinine, WBC and platelets show a statistical significance between acid and alkali.

Endoscopic Evaluation

Endoscopic evaluation of the upper gastrointestinal tract was done in 372 patients (93%). Grading of injury severity was based on Zargar Classification. Findings of 3A and 3B lesions are considered severe mucosal injury or transmural necrosis. Completion rate of upper endoscopies done in the study for caustic injury is at 96.5%, while 3.5% were aborted because of extensive necrosis. Surgical management was done in 28 patients, comprising 7% of the study population. Basic medical management were in place such as NDT insertion (8%), proton pump inhibitors and other supportive measures for all patients admitted (**Table 6**).

Table 6. Grading of injury based on Zargar Classification

	Total	Gr 0	Gr 1	Gr 2A	Gr 2B	Gr 3A	Gr 3B	P-value
				Frequency (%)				
Esophagus								
Medical	33	2 (6.06)	4 (12.12)	12 (36.36)	9 (27.27)	5 (15.15)	1 (3.03)	**<0.001**
Surgical	28	0	0	2 (7.14)	12 (42.86)	6 (21.43)	8 (28.57)	**<0.001**
Cardioesophageal junction								
Medical	33	1 (3.03)	1 (3.03)	12 (36.36)	4 (12.12)	10 (30.3)	5 (15.15)	**<0.001**
Surgical	27	0	0	2 (7.41)	4 (14.81)	4 (14.81)	17 (62.96)	**<0.001**
Cardia								
Medical	33	0	1 (3.03)	3 (9.09)	2 (6.06)	12 (36.36)	15 (45.45)	**<0.001**
Surgical	25	0	0	0	1 (4)	1 (4)	23 (92)	**<0.001**
Fundus								
Medical	33	0	0	3 (9.09)	2 (6.06)	14 (42.42)	14 (42.42)	**<0.001**
Surgical	25	0	0	0	1 (4)	1 (4)	23 (92)	**<0.001**
Body								
Medical	33	0	2 (6.06)	5 (15.15)	2 (6.06)	12 (36.36)	12 (36.36)	**<0.001**
Surgical	25	0	0	0	1 (4)	1 (4)	23 (92)	**<0.001**
Antrum								
Medical	33	2 (6.06)	6 (18.18)	8 (24.24)	3 (9.09)	11 (33.33)	3 (9.09)	**<0.001**
Surgical	22	0	0	2 (9.09)	2 (9.09)	5 (22.73)	13 (59.09)	**<0.001**
Duodenum								
Medical	33	6 (18.18)	11 (33.33)	13 (39.39)	1 (3.03)	2 (6.06)	0	**<0.001**
Surgical	19	2 (10.53)	1 (5.26)	2 (10.53)	3 (15.79)	7 (36.84)	4 (21.05)	**<0.001**

Injury to the esophagus is mostly 2A (36.4%) followed by 2B (27.3%). These are transmucosal injuries seen endoscopically, such as hemorrhage, erosions, blisters, exudates or whitish membranes, and superficial or deep ulcerations. 3B type of injury is seen in majority (28.6%) of those who underwent surgery. The stomach is the most commonly and most severely affected organ in caustic injuries with transmural necrosis (3A and 3B injuries) in the fundus at 42%. Intraoperative findings show that 92% had 3B injuries to the cardia, fundus and body. Severe duodenal transmural necroses (3A and 3B) is noted in 36% of patients.

Discussion

Caustic materials are agents that are acidic or alkaline in nature. In the 2008 annual report of the American Association of Poison Control Centers (AAPCC), the most commonly implicated caustic agent ingested is the alkali sodium hypochlorite, which is found in bleach, toilet bowl cleaners, drain cleaners, and in household disinfectants such as dishwashing agents and detergents. Other substances include anti-rust compounds, pool cleaners, and formic acid. The types of caustic agents most commonly implicated vary between countries. Most caustic substances are ingested in the liquid form and occur at home.[12]

Among acute poisoning cases at the Philippine National Poison Management and Control Center at UP-PGH, caustic substance ingestion accounts for 23% of patients each year.[13] In the UP-PGH data, the five most common caustic agents ingested are sodium hypochlorite, hydrochloric acid, silver jewelry cleaner, oxalic acid, and toilet cleaner. These substances are readily accessible in the Philippines without much regulation as to their access, and are easily purchased over the counter. Silver jewelry cleaners (SJC) are composed mostly of non-cyanide containing solutions; however, earlier production of SJC contained the chemical cyanide, causing neurologic damage and toxicity more so than injuries caused by its caustic property.

Results in this study note an almost equal number of male and female patients in their middle adulthood life. Most patients are unmarried. In this adult population, intentional caustic ingestion is also more common than accidental ingestion, in contrast to reports of incidences among very young kids.

Inasmuch as the authors in this study would have wanted to get predictors of mortality, the very low rate of mortality would have required a much bigger sample size to accurately assess certain variables as predictors. Other studies have identified significant predictors of mortality, such as age, male gender, acid and detergent ingestion, leukocytosis more than 20,000, gastric ulcer, gastric necrosis, and suicidal intent.

The present five-year all-cause mortality rate in this study is 2%, a decrease from the initial 8.1% rate done by an earlier study done at the UP-PGH by Libuit et al. This same study by Libuit et al. showed that metabolic acidosis upon admission, psychiatric disorder, and the need for surgery are associated with high risk of mortality. These predictors were determined in order for clinicians to identify the subset of patients who are at high fatality risk. Such cases, especially those with equivocal physical examination findings, need more aggressive management measures such as emergent surgery.

A wide spectrum of injuries occurs due to ingestion of caustic material, depending on the duration of exposure, type of agent, concentration and volume of substance ingested.

Early endoscopic evaluation is to direct the management approach based on the extent of injury. After resuscitation, there is an urgent need to define the severity, location, and extent of injury. To some extent, this can be based on clinical signs and symptoms such as aphonia, stridor or hoarseness which may indicate laryngeal injury; location of specific pain may indicate mucosal injury to the mouth, esophagus, or stomach; while hematemesis may indicate injury to above-mentioned organs. Radiographic imaging can provide useful information regarding damage, but they do not accurately assess degree, location and extent of injury. Therefore, endoscopy is essential and gives a more accurate picture of injury depth.

Early endoscopic evaluation is recommended since signs and symptoms often do not correlate with the degree of internal injury. The timing of upper endoscopy is often controversial as some recommend doing it after 24 hours to allow time for injury to mature. However, Cheng and Lin recommend it as early as 12 hours,[14] and endoscopy done 48 hours or more post-injury is highly discouraged due to increased risk of perforation from progressive weakening of the gut wall.[15] Earlier reports have also shown that endoscopy

can be safely undertaken 6-96 hours after caustic substance ingestion.[16] There is increased risk or danger of perforation in the subacute phase (5-15 days after ingestion) during which endoscopy should be avoided.[16]

Zargar et al. developed an endoscopic classification system assessing mucosal damage.[17] Patients with grade 1 or 2A injury can be started on oral intake in the first 24 to 48 hours.[18] Observation in the intensive care unit with nutritional support is indicated for grades 2B and 3A without the need for surgical intervention. In those with grade 3B or full thickness necrosis, prompt surgical resection with primary reconstruction may reduce morbidity and mortality. A recent study by Floro et al. at the UP-PGH showed the Zargar classification to be 96.4% sensitive and 10% specific in determining transmural necrosis from caustic injury with an overall diagnostic accuracy of 72.2%.[19]

In a published study by Quingking et al. in 2013 at the UP-PGH on predictive factors of gastrointestinal caustic injury according to clinical and endoscopic findings, only leukocystosis was a significant predictor of higher grades of gastrointestinal injury.[20]

Late complications include esophageal strictures which occur in up to 70% of Grade 2B and more than 90% in those with Grade 3 injuries. Peak development occurs at 8th week post-ingestion although may be reported in as early as three weeks. Corrective surgery is done where endoscopic therapy such as dilation fails or is deemed high risk. Surgical options include partial or total esophagectomy with gastric pull-up or colonic interposition. Mortality rates of late reconstructive surgery depend on local surgical expertise.

The data in this study were collected retrospectively, on a population limited to those who presented acutely in the emergency room, which is its great limitation. Late sequelae were not looked into, but could possibly be done by future studies.

More powerful prospective studies in the future conducted on a bigger population for a longer duration of study may identify predictive factors and help put up a set of guidelines which can improve the immediate management of patients.

Conclusion

The results of this study show that there were 80 admitted cases of caustic ingestion per year at the UP-PGH. Intentional ingestion is seen in most cases. Acidic agents cause majority of mortality outcomes. Mortality rate is low and mostly attributed to hospital acquired infection post-surgery.

Endoscopy is considered a cornerstone in the diagnosis of CMI. The endoscopic Zargar classification of severity of injury is an important aid in the management decision making of these cases.

Conflicts of Interest

The authors declare no conflicts of interest.

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