INDICATORS OF THE NEED FOR INTENSIVE CARE UNIT ADMISSION IN PATIENTS ACUTELY EXPOSED TO CORROSIVE SUBSTANCES WITH CONCERN TO ENDOSCOPIC ASSESSMENT, TANTA UNIVERSITY POISON CONTROL CENTER, EGYPT

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ABSTRACT

Background: Acute corrosive poisoning constitutes a significant health concern, characterized by a considerable incidence of severe morbidity and mortality. **Aim of the work:** This study aimed to identify patterns, potential indicators for the need for intensive care unit (ICU) admission in patients acutely exposed to corrosive substances, and endoscopic findings in patients who developed strictures. **Patients and methods:** This cross-section study included 70 patients with acute corrosive poisoning admitted to Tanta University Poison Control Center, Egypt, between September 2023 and September 2024. Patients were categorized into ICU-admitted patients and non-ICU-admitted patients. Outcomes were monitored and a gastroendoscopist followed the patients for 3 months. **Results:** The prevalence of corrosive poisoning was 7.9 % of all poisoned patients while the incidence of ICU admission was 18.6 % of all acute corrosive poisoning. Tachycardia, hypotension, vomiting, respiratory distress, hematemesis, pharyngeal involvement, need for endotracheal intubation, mechanical ventilation, tracheostomy, esophageal stricture, and surgical intervention were significantly high in ICU-admitted patients. In univariate analysis, age, hypotension, vomiting, hematemesis, esophageal stricture, and pharyngeal involvement were significant indicators for ICU admission. In multivariate analysis, esophageal stricture was a significant late indicator of the need for ICU admission. Furthermore, pulse rate, systolic, diastolic and temperature were the most reliable indicators for ICU admission. **Conclusions:** Patients presenting with vomiting, hematemesis, tachycardia, hypotension, and fever with late presentation of stricture are significant indicators of ICU admission. The incidence of esophageal and/or gastric strictures was 17.1% of the corrosive patients. Upper gastrointestinal endoscopic dilatation is an effective one month post-corrosive exposure.

Keywords: *Corrosive poisoning; Intensive care unit; Indicators; Stricture; Endoscope.*

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INTRODUCTION

Corrosive ingestion remains a significant public health concern in emerging nations. In Egypt, ***Kandeel and El-Farouny (2017)*** study revealed that 30% of poisoning cases at the Menoufia Poison Control Center (MPCC) were attributable to corrosives. Moreover, corrosives accounted for approximately 58% of pediatric poisoning cases reported to the Middle Delta Poison Control Center ***(Sobeeh et al., 2018)***.

The most frequently consumed corrosive substances are typically classified as acids and alkalis. Sodium hydroxide is a common alkali found in bathroom cleaners and dishwashing agents, whereas toilet cleaning products typically contain sulfuric or hydrochloric acid. Solid corrosive keep to the oropharynx and hypopharynx, resulting in widespread damage, however, liquids travel rapidly, affecting the esophagus and stomach ***(Abbasi et al., 2023)***.

Ingesting caustic substances may result in either the absence of symptoms or the emergence of significant complications. The symptoms may include vomiting, drooling, chest pain, abdominal pain, and respiratory and swallowing difficulties. Hematemesis is the result of erosion of the blood vessels ***(Poonthottathil et al., 2023)***. Additionally, edema of the upper airway was evident, which resulted in alterations to the voice, stridor, and respiratory distress. In cases where the esophagus has been perforated, the subsequent development of mediastinitis and peritonitis is a potential outcome. Mediastinitis presents with tachycardia, fever, and the Hamman sign, which is characterized by a systolic precordial crunching sound detected upon auscultation. Peritonitis presents with abdominal discomfort and rigidity ***(Simonovska et al., 2023)***.

The management of corrosives ingestion presents a substantial challenge due to the detrimental impact they can have on the upper gastrointestinal system, both acutely and chronically ***(Kluger et al., 2015)***. Despite the substantial tissue damage that occurs shortly after the ingestion of caustic substances, the administration of appropriate therapy during the acute phase can help mitigate the progression of these injuries and facilitate subsequent care in the chronic phase. The inadequate management of acute corrosive injuries can lead to significant chronic complications ***(Hall et al., 2019)***.

The management of corrosive ingestion is divided into three phases: early, middle, and chronic. The initial phase of management entails the expeditious evaluation of the extent of injury, resuscitation, and the formulation of a plan for subsequent care during the acute phase. The intermediate phase pertains to the management of acute cases in hospitals, with a particular focus on sepsis, aspiration, and feeding. The chronic phase addresses the management of long-term complications resulting from corrosive ingestion, such as strictures ***(Di Maggio et al., 2022; Almajed et al., 2024)***.

In the acute phase of injury, the primary objective of treatment is to reduce the extent of damage while maintaining airway, breathing, and circulation. In cases where there is airway edema or an upper airway injury, an ear, nose, and throat surgeon is required for nasopharyngolaryngoscopy and tracheostomy ***(Gangakhedkar et al., 2020)***. During these phases, patients usually require intensive care unit admission for proper management ***(Di Maggio et al., 2022)***.

The determination of admission to the intensive care unit (ICU) for patients suffering from acute corrosive poisoning is contingent upon several factors, including the extent of damage incurred, the presence of concomitant medical conditions, and the overall clinical state of the patient. However, there is a paucity of studies that have examined the indications for ICU admission in patients with corrosive exposure ***(Sharif et al., 2022; Abdelnoor et al., 2023)***.

Furthermore, an early upper gastrointestinal endoscopy could be performed within 48 hours of ingestion to inform subsequent therapy. However, most endoscopists prefer to delay the endoscopic intervention to avoid iatrogenic perforation ***(Kalayarasan et al., 2019)***.

THE AIM OF THE WORK

The objective of this study was to ascertain the patterns, and potential indicators for the need for ICU admission in patients acutely exposed to corrosive substances, as well as endoscopic findings in patients who developed strictures.

PATIENTS AND METHODS

Study design and setting

This cross-sectional study was conducted at the Tanta University Poison Control Center (TUPCC) Emergency Hospital, Tanta University, Egypt. Data were gathered from September 2023 to September 2024.

The study was approved by the Research

Ethical approval

Ethical Committee, Faculty of Medicine, Tanta University, Egypt. The approval number was *36264PR310/8/23*. The study's objectives and methodology were thoroughly explained to all participants, and informed consent was obtained from each participant or their legal guardians prior to the initiation of the study. A coding system was implemented to ensure the confidentiality and privacy of patients' records and data.

Eligibility criteria

All symptomatic patients with acute corrosive exposure by any route (oral, inhalation, or dermal) who were admitted to TUPCC during the study period were included, irrespective of gender or age. The absence of restrictions based on sex or age was implemented to ensure the comprehensive detection of patterns associated with acute corrosive poisoning in TUPCC.

In order to avoid the potential for misleading endoscopic findings, patients who had been exposed to other substances in addition to corrosive substances, who had a previous corrosive ingestion, and who had a delayed presentation of ≥12 hours were excluded from the study. Additionally, patients who were pregnant, had comorbidities including cardiac, renal, hepatic, and neurological conditions, those who declined to participate, and subjects with incomplete data were excluded from the study.

Data collection

Acute corrosive poisoning was diagnosed based on the patient's history and clinical examination of corrosive exposure according to the ICD-10 system for caustic injury and chemical burn (ICD-10 code T27.x and T28.x). Upon admission to the hospital, all patients underwent a comprehensive history and clinical assessment. The following data were recorded: age, sex, residence, sociodemographic data, mode of poisoning, type of corrosive, amount of corrosive, and time elapsed before arrival at the hospital. The assessment of the amount of corrosive substance ingested was based on detailed patient history, where possible, corroborated by caregivers who observed the ingestion. In instances of accidental ingestion, which was prevalent among children, caregivers frequently offered estimates based on the quantity remaining in the container and the initial amount present. For adult cases, especially those involving intentional poisoning, patients were asked to provide an estimate of the volume consumed. In addition, a comprehensive documentation of clinical characteristics and vital signs was performed.

Patient management

The treatment protocol included rescue and supportive therapy, appropriate fluid support, and proton pump inhibitors. Oral intake was withheld, and parenteral feeding was initiated until perforation or significant mucosal injury was excluded and the patient's condition had stabilized. Antibiotics and steroids were administered at the discretion of the attending physician. Aspiration pneumonia was identified through the use of chest radiography (CXR) or computed tomography (CT) scans. The intensivist subsequently determined that ICU admission was necessary, primarily for the purposes of hemodynamic stabilization, respiratory assistance, mechanical ventilation, and the careful management of comatose patients. Tracheostomy with mechanical breathing was indicated in individuals with laryngeal injury.

Outcomes:

In this study, eligible patients were divided into two groups based on their need for ICU admission at any time during their poisoning: those not admitted and those admitted to the ICU. An experienced endoscopist managed the patients for 3 months, during which they attended frequent follow-up visits. According to the ICU admission, patients were monitored for the need for antibiotics, duration of steroid intake, the need for endotracheal intubation (ETT), mechanical ventilation, tracheostomy, length of hospital stays before ICU admission, stricture formation, and the need for surgical intervention.

Statistical Analysis

Data was analyzed using the Statistical Package for Social Sciences (IBM SPSS Statistics) version 26 (IBM Corp., Armonk, NY, USA). The normality of the distribution of numerical values was evaluated using the Shapiro-Wilk test. Variables exhibiting a normal distribution were summarized using the mean±standard deviation (SD). Non-normally distributed numerical variables were summarized using the median and interquartile range (IQR), which denotes the 25th and 75th percentiles. Pearson’s chi-square test was used to assess the association between the investigated outcomes and categorical variables. The Mann-Whitney tests were utilized to examine the data. Categorical variables were expressed as frequencies and proportions. Sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV), and positive and negative likelihood ratios were calculated. Binary logistic regression analysis was performed to identify factors predicting

ICU admission. Statistical significance was defined as a p-value of <0.05.

RESULTS

During the study period, the total number of poisoned patients who were admitted to TUPCC was 2322 poisoned patients. The total assigned corrosive poisoned patients were 184 patients (7.9 %). Of those, 114 patients failed to be eligible. Forty-five patients were asymptomatic, 33 patients were lost to follow-up, 26 patients refused to participate in the study, 8 patients had cardiac and renal comorbidities, and 2 pregnant females. This study included 70 patients with acute corrosive exposure that were divided to two groups. Of the total number of patients included in the study, 13 (18.6%) were admitted to the intensive care unit (ICU). Conversely, 57 (81.4%) patients did not require admission to the ICU **(Figure 1)**.

Figure (2) demonstrates the trend of assigned acute corrosive poisoned patients in relation to the total admitted poisoned patients. The highest percentage of corrosive patients was during April and June 2024.

The median age of the patients was 3 years with an IQR (2-24). Gender and residence did not show any significant differences between groups (p=0.356 and 0.763, respectively). The amount of the ingested corrosive substance and the time elapsed before hospital admission did not significantly differ between groups. Among patients who were admitted to ICU, acidic substances and accidental poisoning were significantly higher than those who were not admitted to ICU (p<0.001 and 0.029, respectively) **(Table 1)**.

Table (2) shows the clinical characteristics and vital signs among the studied groups. Vomiting, respiratory distress, abdominal pain, and hematemesis were significantly higher incidences among ICU-admitted patients than non-ICU-admitted patients (p<0.001, 0.0173, 0.035, and 0.010, respectively). While, hoarseness of voice, drooling of saliva, and tongue lesion, did not differ statistically between groups (p=0.124, 0.151, and 0.268, respectively). Concerning vital signs, patients who were admitted to ICU had significantly higher incidences of tachycardia, hypotension, and fever than those who were not admitted to ICU.

Figure (3) shows oral lesions including lip and tongue edema, redness, and drooling of saliva in a 6-year-old boy with accidental sulphuric acid ingestion.

Concerning the treatment outcomes, the need for ETT, mechanical ventilation, tracheostomy and surgical interference were significantly higher in patients who were admitted to ICU compared to the other group. Through endoscopic assessment, stricture and pharyngeal involvement were significantly noticed among ICU-admitted patients (p<0.001 and 0.002, respectively) **(Table 3)**.

The results of the univariate and multivariate logistic regression analyses highlight key factors associated with ICU admission. In the univariate model, significant indicators included age, blood pressure, vomiting, hematemesis, esophageal stricture, and pharyngeal involvement.

However, in the multivariate analysis, only esophageal stricture remained a significant independent indicator (p=0.0077, OR=171.22), indicating its strong association with severe outcomes requiring ICU care. While factors such as blood pressure and vomiting were significant in univariate analysis, they lost significance in the multivariate model, suggesting that their effects were likely mediated by the presence of esophageal stricture **(Table 4)**.

Table 5 shows that among the vital signs, *pulse rate* was the most reliable indicator of ICU admission, with the highest specificity (98.2%) and positive likelihood ratio (+LR=43.85), making it effective at correctly identifying those who do not need ICU care (NPV=94.4%). *Systolic (SBP) and diastolic blood pressure (DBP)* also demonstrate high specificity (91.2%) and strong NPVs, particularly SBP (94.5%), making them good indicators for ruling out ICU admission. *Temperature* was a weaker indicator, with moderate sensitivity and specificity.

Overall, pulse rate was the strongest indicator of ICU admission.

Table (6) provides an overview of cases involving corrosive substance ingestion, detailing patient demographics, the type of substance ingested, endoscopic findings, and interventions. Acidic substances predominantly caused esophageal strictures, often requiring endoscopic dilation, while alkaline substances frequently led to combined esophageal, gastric and duodenal strictures and dilation, primarily managed by surgical intervention or endoscopic dilation.

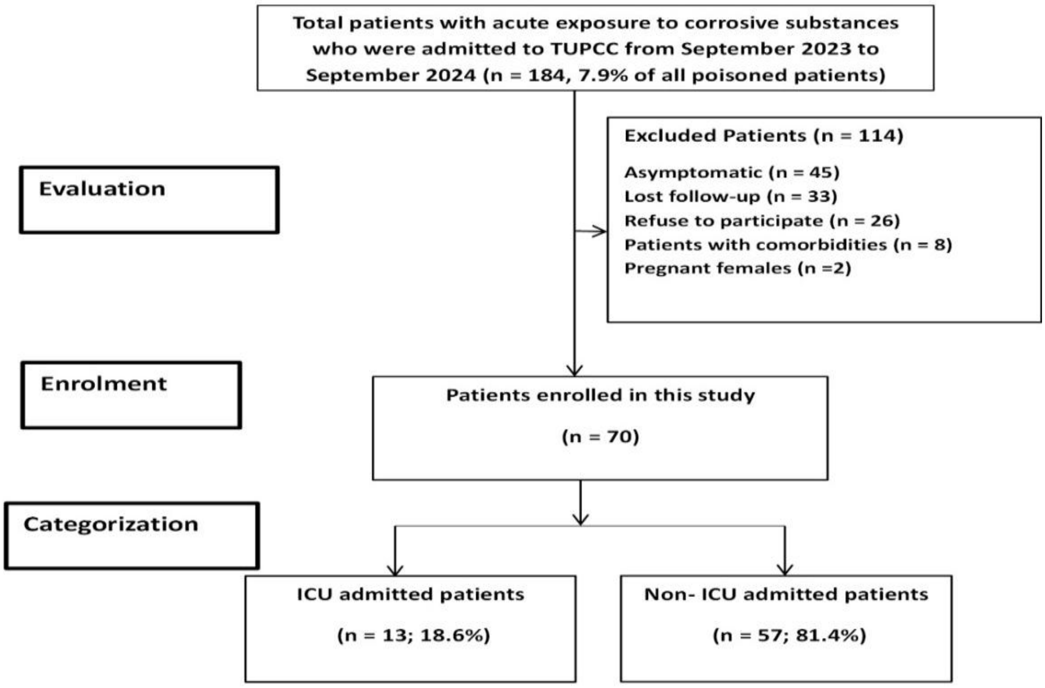

Figure (1): Flowchart of patients with acute exposure to corrosive substances admitted to TUPCC.

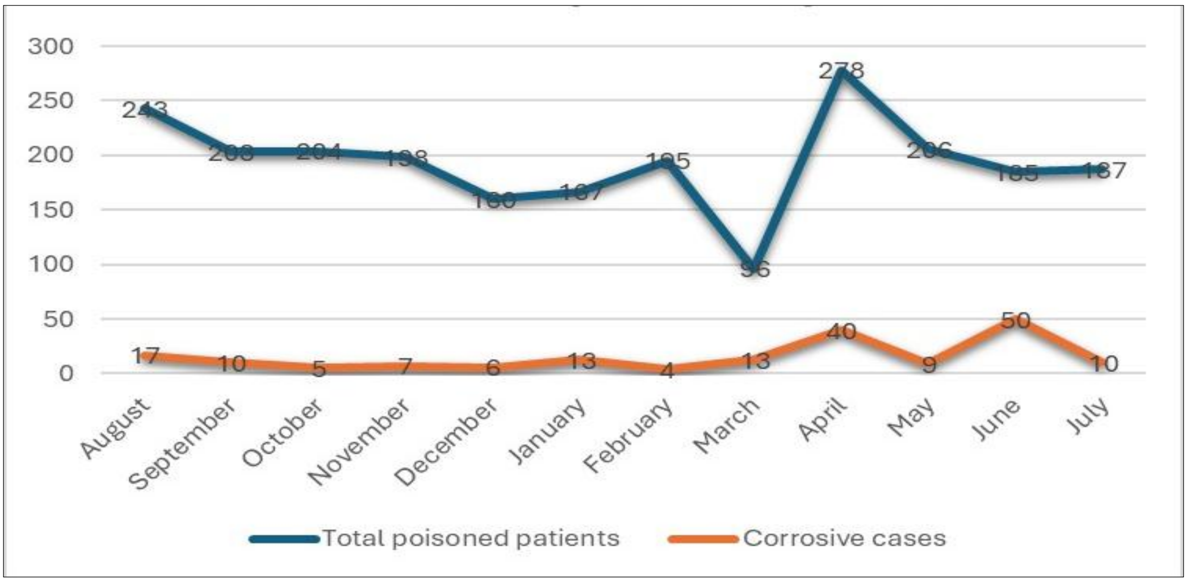

Figure (2): Trend of the assigned corrosive patients in relation to total poisoned patients at TUPCC (Number of total acute corrosive patients =184 (7.9 %).

Figure (3): Oral lesion (swelling, redness, drooling of saliva) in a-6-year-old child with sulphuric acid ingestion

Table (1): Sociodemographic and toxicological characteristics among patients with acute corrosive poisoning (n=70).

Patient characteristics	Patients need ICU (n=13, 18.6%)	Patients didn't need ICU (n=57, 81.4%)	Total (n=70)	Test	P-value
Sex, n (%)				X^2=0.850	0.356
Female	8 (61.5%)	27 (47.4%)	35 (50%)		
Male	5 (38.5%)	30 (52.6%)	35 (50%)		
Age, years (median, IQR)	6.0 (4.75-40.0)	2 (2.0-19.0)	3 (2.0-24.0)	Z= -2.085	0.037*
Residence, n (%)				X^2=0.091	0.763
Rural	11 (84.6%)	50 (87.7%)	61 (87.1%)		
Urban	2 (15.4%)	7 (12.3%)	9 (12.9%)		
Socioeconomic status, n, (%)					
Low	7 (53.8%)	13 (22.8%)	20 (28.6%)	X^2=6.870	0.032*
Moderate	1 (7.7%)	23 (40.4%)	24 (34.3%)		
High	5 (38.5%)	21 (36.8%)	26 (37.1%)		
Type of substance, n (%)					
Acid	7 (53.8%)	29 (50.9%)	36 (51.4%)	X^2=20.689	<0.001*
Alkali	2 (15.4%)	20 (35.1%)	22 (31.4%)		
Mixed	4 (30.8%)	8 (14.0%)	12 (17.2%)		
Amount of substance, n (%)				X^2=0.037	0.847
less than 100 mL	6 (46.2%)	28 (49.1%)	34 (48.6%)		
more than 100 mL	7 (53.8%)	29 (50.9%)	36 (51.4%)		
Mode of toxicity, n (%)				X^2=4.794[a]	0.029*
Accidental	11 (84.6%)	56 (98.2%)	67 (95.7%)		
Suicidal	2 (15.4%)	1 (1.8%)	3 (4.3%)		
Delay in hours (median, IQR)	1.0 (1.0-2.50)	1.0 (1.25-2.0)	1.50 (1.0-2.0)	Z= -0.347[b]	0.729

*IQR: interquartile range; N: number; X^2: Pearson's Chi-square test for independence of observations; Z: Mann-Whitny; *significant at p<0.05.*

Table (2): Clinical characteristics and vital signs among patients with acute corrosive ingestion (n=70).

Clinical characteristics, n (%)	Patients need ICU (n=13, 18.6%)	Patients didn't need ICU (n=57, 81.4%)	Total (n=70)	Test	P-value
Vomiting				$X^{2=}$29.202	<0.001*
Yes	10 (76.9%)	5 (8.8%)	15 (21.4%)		
No	3 (23.1%)	52 (91.2%)	55 (78.6%)		
Hoarseness of voice				$X^{2==}$2.362	0.124
Yes	9 (69.2%)	26 (45.6%)	35 (50.0%)		
No	4 (30.8%)	31 (54.4%)	35 (50.0%)		
Drooling of saliva				$X^{2=}$2.060	0.151
Yes	13 (100.0%)	49 (86.0%)	62 (88.6%)		
No	0	8 (14.0%)	8 (11.4%)		
Respiratory distress					
Absent	0	8 (14.0%)	8 (11.4%)	$X^{2=}$ 10.160	0.0173*
First degree	4 (30.8%)	12 (21.1%)	16 (22.9%)		
Second degree	1 (7.7%)	23 (40.4%)	24 (34.3%)		
Third degree	8 (61.5%)	14 (24.6%)	22 (31.4%)		
Tongue lesion				$X^{2=}$1.288	0.268
Yes	13 (100.0%)	52 (91.2%)	65 (92.9%)		
No	0	5 (8.8%)	5 (7.1%)		
Pharyngeal involvement					
Yes	7 (53.8%)	8 (14.0%)	15 (21.4%)		
No	6 (46.2%)	49 (86.0%)	55 (78.6%)	$X^{2=}$9.965	0.002*
Abdominal pain				$X^{2=}$4.463	0.035*
Yes	11 (84.6%)	30 (52.6%)	41 (58.6%)		
No	2 (15.4%)	27 (47.4%)	29 (41.4%)		
Hematemesis				$X^{2=}$6.614	0.010*
Yes	7 (53.8%)	11 (19.3%)	18 (25.7%)		
No	6 (46.2%)	46 (80.7%)	52 (74.3%)		
Pulse, bpm, (median, IQR)	150.0 (129.0-165.0)	120.0 (97.0-130.0)	122 (97.0-130.0)	Z=-4.166	<0.001*
Normal	1 (7.7%)	21 (36.8%)	22 (31.4%)	X^2=4.174	0.041*
Tachycardia	12 (92.3%)	36 (63.2%)	48 (68.6%)		
Blood pressure					
Normal	3 (23.1%)	52 (91.2%)	55 (78.6%)	X^2=29.202	<0.001*
Hypotension	10 (76.9%)	5 (8.8%)	15 (21.4%)		
Temperature,° C, (median, IQR)	38.50 (37.0-38.7)	37.0 (37.0-37.0-37.5)	37.0 (37.0-38.0)	Z=--2.556	0.011*
Normal	4 (30.8%)	44 (77.2%)	48 (68.6%)	X^2=10.58	0.001*
Fever	9 (69.2%)	13 (22.8%)	22 (31.4%)		

*N: number; X^2: Pearson's Chi-square test for independence of observations; Z: Mann-Whitny; *significant at p<0.05.*

Table (3): Outcomes among patients with acute corrosive poisoning (n=70).

	Patients need ICU (n=13, 18.6%)	Patients didn't need ICU (n=57, 81.4%)	Total (N=70)	Test	P-value
Duration of steroid use, days, (median, IQR)	7.0 (4.5-10.0)	1.0 (0.0-1.50)	1.0 (1.0-2.25)	Z=--5.089	<0.001*
Antibiotic use					
Yes	13 (100.0%)	49 (86.0%)	62 (88.6%)	X^2=2.060	0.161
No	0	8 (14.0%)	8 (11.4%)		
ETT, n (%)					
Yes	2 (15.4%)	0	2 (2.9%)	X^2=9.027	0.003*
No	11 (84.6%)	57 (100.0%)	68 (97.1%)		
MV, n (%)					
Yes	2 (15.4%)	0	2 (2.9%)	X^2=9.027	0.003*
No	11 (84.6%)	57 (100.0%)	68 (97.1%)		
Tracheostomy, n (%)					
Yes	2 (2.9%)	0	2 (2.9%)	X^2=9.027	0.003*
No	11 (84.6%)	57 (100.0%)	68 (97.1%)		
Esophageal /or gastric Stricture					
Yes	10 (76.9%)	2 (3.5%)	12 (17.1%)		
No	3 (23.1%)	55 (96.5%)	58 (82.9%)	$X^{2=}$40.167	<0.001*
LOS at TUPCC, days, (median, IQR)	2.0 (1.0-12.0)	2.0 (1.0-12.0)	2.0 (1.0-2.0)	Z=--1.386	0.166
Surgery, n (%)					
Yes	4 (30.8%)	0	4 (5.7%)	X^2=18.601	<0.001*
No	9 (69.2%)	57 (100.0%)	66 (94.3%)		

*MV: mechanical ventilation; ETT: endotracheal intubation; LOS: length of hospital stay; TUPCC: Tanta University Poison control Center; IQR: interquartile range; N: number; X2: Pearson's Chi-square test for independence of observations; Z: Mann-Whitny; *significant at p<0.05*

Table (4): Univariate and Multivariate binary logistic regression analysis model for identifying the need for intensive care unit (ICU) admission among patients with acute corrosive poisoning (n=70).

	Univariate		Multivariate	
	P value	**OR (95% CI)**	**P value**	**OR (95% CI)**
Age	0.031*	1.03 (1.00-1.059)	0.1431	1.06 (0.97-1.15)
Socioeconomic status	0.204	0.63 (0.29-1.35)		
Mode of toxicity	0.067	10.18 (0.84-122.31)		
Type of corrosive	0.147	0.34 (0.083-1.45)		
Pulse	0.070	7.00 (0.84-57.72)		
Blood pressure	<0.001*	34.66 (7.11-168.86)	0.1808	13.59 (0.297-621.73)
Temperature	0.523	1.12 (0.78-1.61)		
Vomiting	<0.001*	34.66 (7.11-168.86)	0.2556	7.03 (0.24-203.54)
Abdominal pain	0.066	4.50 (0.90-22.39)		
Hematemesis	0.0147*	4.87 (1.36-17.43)	0.8412	0.75 (0.045-12.50)
Esophageal /or gastric stricture	<0.001*	39.75 (7.59-208.09)	0.0077*	171.22 (3.89-7530.56)
Respiratory distress	0.0783	1.92 (0.92-3.97)		
Pharyngeal involvement	0.008*	6.12 (1.57-23.77)	0.6673	0.47 (0.015-14.53)

*ICU: intensive care unit; OR: odds ratio; CI: confidence interval; *significant at p<0.05.*

Table (5): Sensitivity, specificity, PPV and NPP of vital signs in identifying the need for ICU admission among patients with acute corrosive poisoning (n=70).

	Sensitivity (%)	Specificity (%)	PPV (%)	NPV (%)	+ LR	- LR
SBP (mmHg)	76.9	91.2	66.7	94.5	8.77	0.25
DBP (mmHg)	69.2	91.2	64.3	92.9	7.89	0.34
Pulse (bpm)	76.9	98.2	90.0	94.4	43.85	0.23
Temperature (° C)	69.2	78.9	42.9	91.8	3.29	0.39

*SBP: Systolic blood pressure; DBP: diastolic blood pressure; PPV: positive predictive value; NPV: negative predictive value; + LR: positive likelihood ratio; -LR: negative likelihood ratio; *: significance at p<0.05.*

Table (6): Upper endoscopic assessment of corrosive poisoned patients who developed stricture (n=12).

Cases No	Sex	Age, years	Substance ingested	Endoscopic finding	Intervention
1	Female	33	Acidic	Esophageal Stricture	Endoscopic dilation with Savary- Gilliard dilators.
2	Male	1	Alkaline	Esophageal Stricture	Surgical feeding gastrostomy and endoscopic dilation with Savary- Gilliard dilators.
3	Female	19	Acidic	Esophageal stricture	Endoscopic dilation with Savary- Gilliard dilators.
4	Male	59	Acidic	Esophageal and mid-gastric Strictures	Surgical feeding jejunostomy and endoscopic dilation with balloon and Savary- Gilliard dilators.
5	Male	3.5	Alkaline	Esophageal stricture	Surgical feeding gastrostomy and endoscopic dilation with balloon and Savary- Gilliard dilators.
6	Female	39	Acidic	Esophageal gastric and duodenal bulb strictures	Surgical feeding jejunostomy and endoscopic dilation with balloon and Savary- Gilliard dilators.
7	Female	30	Acidic	Esophageal Stricture	Endoscopic dilation with Savary- Gilliard dilators.
8	Female	4	Alkaline	Esophageal stricture	Endoscopic dilation with Savary- Gilliard dilators.
9	Female	45	Alkaline	Esophageal stricture	Endoscopic dilation with Savary- Gilliard dilators.
10	Female	75	Acidic	Esophageal Stricture	Endoscopic dilation with Savary- Gilliard dilators.
11	Female	10	Alkaline	Esophageal stricture	Endoscopic dilation with Savary- Gilliard dilators.
12	Female	6	Acidic	Esophageal Stricture	Endoscopic dilation with Savary- Gilliard dilators.

Case presentation

Among the studied patients, 12 patients developed stricture formation and required dilation by endoscopy, while these 4 patients had surgical intervention through jejunostomy and/or gastrostomy tube insertion.

<u>Case 1</u>

A 39-year-old female had a documented history of psychiatric illness. The patient presented to the poison control center with a history of ingestion of a cleaning substance, specifically Flash, an acid corrosive. The patient exhibited severe oral lesions, vomiting, abdominal discomfort, and respiratory distress. The treating toxicologist provided emergency conservative treatment. Subsequently, she was referred to an endoscopist for the management of dysphagia. Upon endoscopic assessment, it was determined that a non-passable stricture in the esophagus, located 18 cm from the dental arch **(Figure 4-A)**, precluded further advancement of the endoscope. Dilation of the stricture with Savary-Gilliard bougies was performed up to 11 mm **(Figure 4-B)**. The subsequent advancement of the neonatal scope revealed severely inflamed gastric mucosa with antral stricture, indicating the necessity for medical treatment and dilation in the subsequent session **(Figure 5)**. At that juncture, the patient was admitted to the ICU to address the issues of dehydration, nutritional deficiencies, and electrolyte imbalances. She was also referred to a gastrointestinal surgeon for the insertion of a jejunostomy feeding tube. Additionally, the patient was admitted for a second time for intensive care, as the feeding jejunostomy tube had become dislodged, necessitating a surgical consultation and reinsertion of the feeding tube. Subsequently, with follow-up sessions of endoscopic dilation of strictures, the severely inflamed edematous stomach underwent a transformation into a gastric pouch with extensive fibrosis and multiple diverticulae **(Figure 6)**. The dilation of the esophageal stricture was continued using Savary-Gilliard bougies, and trials were conducted to dilate the severely stenotic pylorus **(Figure 7)** and duodenal bulb using a dilation balloon in multiple sessions **(Figure 8)**. This resulted in the dilation of the stenosed segment with a length of approximately 10 cm **(Figure 9, A and B)** to reach the healthy second part of the duodenum **(Figure 9, C)**.

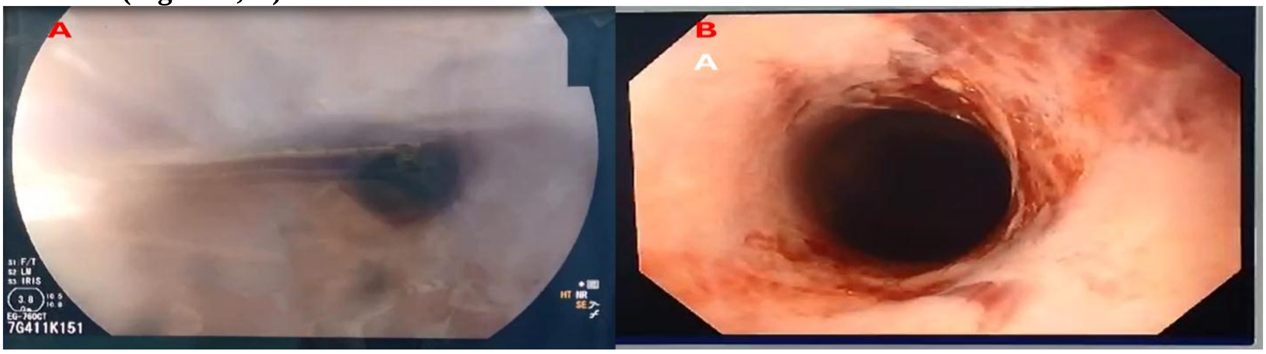

Figure (4): Upper gastrointestinal endoscopy findings (CASE 1); (A) an esophageal non-passable stricture 18 cm from the dental arch; (B) Dilation of the stricture with (Savary-Gilliard) bougies was done up to 11 mm.

Figure (5): Severely inflamed gastric mucosa with antral stricture

Figure 6: (A) Gastric pouch with extensive fibrosis and multiple diverticulae; (B and C) Severely stenotic pylorus with food remnants due to gastric outlet obstruction.

Figure (7): The fluoroscopic view of balloon dilation of the pylorus and duodenal bulb and passage of the contrast media to the 2nd part of the duodenum.

Figure (8): The endoscopic view of pyloric and duodenal bulb stricture before (A) and after dilation (B) and balloon dilation of the pylorus and duodenal bulb (C)

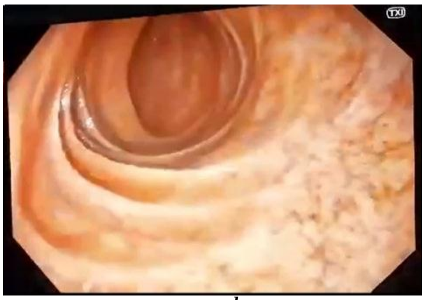

Figure (9): The healthy 2nd part of the duodenum.

Case 2

A one-year-old male patient presented with chief complaints of upper abdominal discomfort and severe emesis following the inadvertent ingestion of potassium hydroxide one month prior. A physical examination revealed minor epigastric distension. In the month preceding admission to our hospital, the patient had undergone conservative treatment at TUPCC, which included the correction of nutritional deficits. An endoscopic examination revealed a severe (pinpoint) long-segment stricture in the mid esophagus **(Figure 10)**, which was dilated with Savary-Gilliard bougie dilators up to 5 mm **(Figure 11)**. Subsequently, a feeding gastrostomy tube was performed. The patient was discharged without incident on the second day following surgery. Over a six-month period, subsequent endoscopic sessions demonstrated a gradual increase in the dilator's diameter, ultimately reaching 12 mm, accompanied by an enhancement in swallowing. There were no problems or reports of symptom recurrence until the most recent follow-up, which occurred approximately two months ago.

Figure (10): Severe (pinpoint) mid esophageal long segment stricture.

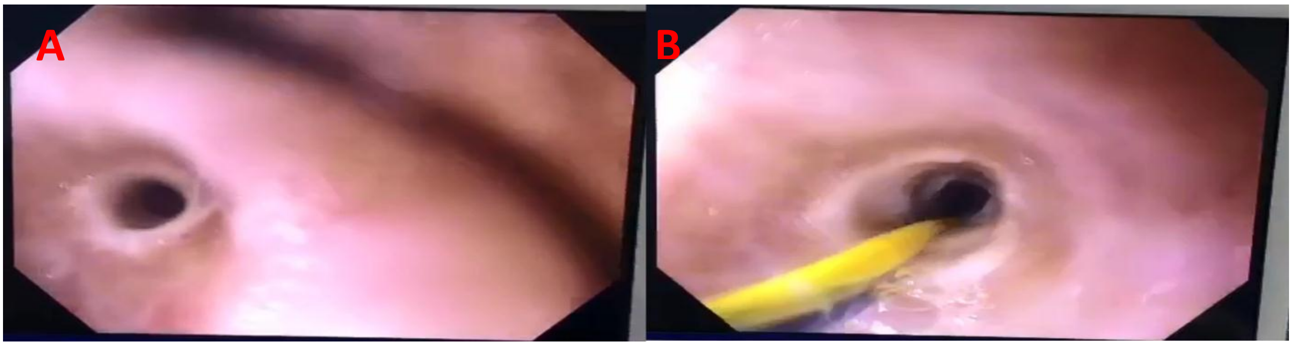

Figure (11): Esophageal stricture before dilation (A) and after dilation using Savary- Gilliard bougie dilators up to 5 mm with a guidewire in the view (B).

Case 3

A 59-year-old male with a history of diabetes mellitus ingested sulfuric acid inadvertently and was subsequently presented to our TUPCC. The patient reported severe abdominal tenderness and shortness of breath, as well as concurrent intense pain in the mouth and throat, hoarseness, and difficulty in swallowing. Upon arrival, the patient's vital signs were temperature, 38.3°C; blood pressure, 100/70 mmHg; pulse rate, 135 beats per minute; and respiratory rate, 33 breaths per minute. The physical examination revealed an eroded oral cavity and diffuse abdominal pain. Following a three-week course of conservative treatment, an endoscopy was performed by a consulting gastroenterologist, which revealed diffuse, severe, circumferential esophageal ulcerations **(Figure12-a)**. A severe stricture of the upper esophagus, located 20 cm from the oral incisor, prevented further advancement of the endoscope. Short stenotic segments (less than 2 cm) were observed, and dilations with Savary-Gilliard bougies were performed up to 7 mm. Following dilation in the same session, the neonatal scope was advanced to assess the stomach, which demonstrated severely inflamed, erythematous, and friable gastric mucosa at the proximal stomach and stricture at the mid stomach **(Figure 13-a)**. A jejunostomy tube was subsequently applied via surgical intervention. Subsequently, endoscopic dilation sessions were conducted, resulting in esophageal dilation up to 11 mm using Savary-Gilliard bougies (Fig. 12-b). The mid-stomach stricture was dilated using a dilation balloon **(Figure 13-b)**.

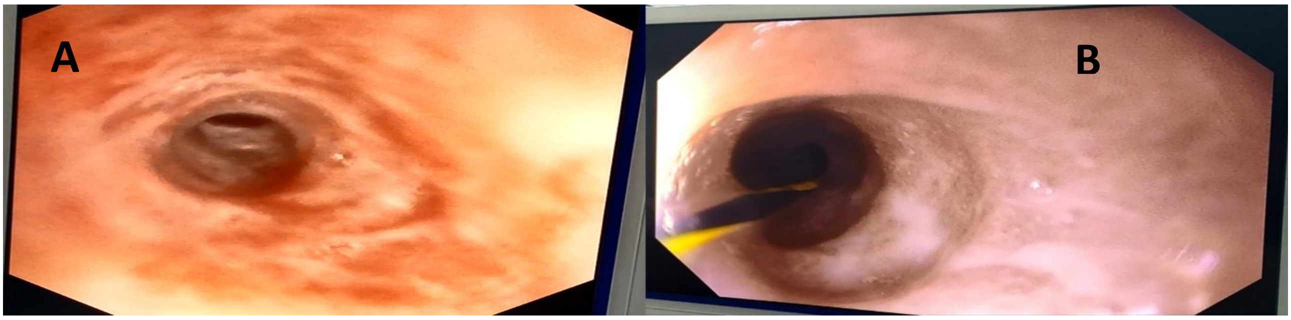

Figure (12): (A) Severe circumferential narrowed esophagus; (B) esophagus after dilatation (11 mm).

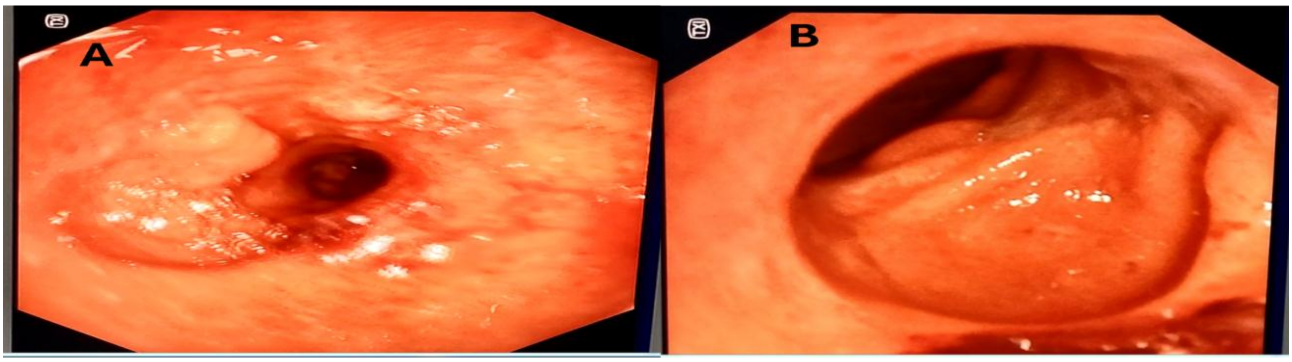

Figure (13): (A) Severely narrowed stomach; (B) stomach after dilatation .

Case 4:

A 3.5-year-old male child presented with progressive dysphagia, having previously ingested sodium hydroxide one month prior. At the time of ingestion, the patient was admitted to the ICU and received treatment in the form of IV fluids, antibiotics, and steroids for a period of 11 days. However, the patient subsequently exhibited persistent vomiting of all ingested substances and developed severe dehydration, necessitating readmission to the hospital to address the child's condition. He received supportive treatment and underwent a barium study, which revealed a severe esophageal stricture. To address his malnutrition, a feeding gastrostomy was performed, followed by a gastroscopy that revealed a pinpoint upper esophageal stricture that precluded the advancement of the guidewire (0.035 inches, or 0.9 mm). A 6-mm neonatal gastroscope was inserted through the gastrostomy opening, and the guidewire was introduced into the esophagus in a retrograde manner from the stomach, guided by fluoroscopy **(Figure 14)**. Subsequently, the scope was withdrawn and reinserted through the mouth, receiving the guidewire **(Figure 15)**. The subsequent dilation of the esophagus was performed using the Savary-Gilliard dilator, achieving a maximum dilation of 5 mm during the initial dilation session. The subsequent dilation session, conducted a week later, achieved dilation up to 7 mm. In the ensuing dilation sessions, which have occurred over a period of six months, the utilization of Savary-Gilliard dilators up to 9 and 10 mm, in conjunction with balloon dilation up to 10 mm **(Figures 16 and 17)**, has been employed. This approach has led to an enhancement in his overall condition; however, he continues to rely on feeding gastrostomy as a nutritional supplement.

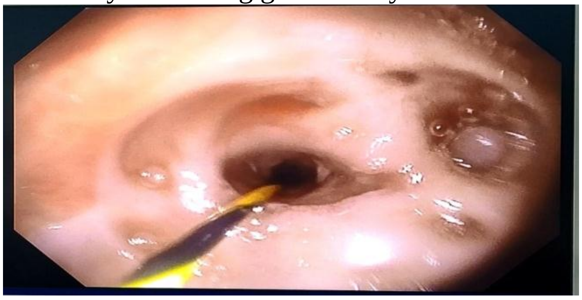

Figure (14): Endoscopic view of the cardia (gastric side) from the stomach as the scope was introduced through the gastrostomy opening.

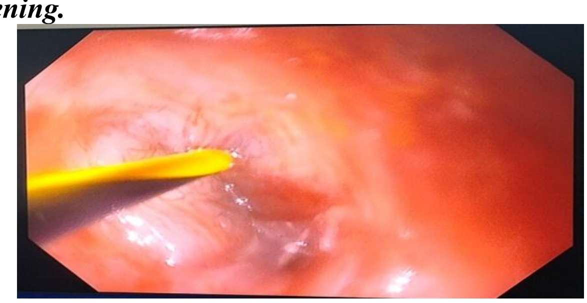

Figure (15): Severe esophageal stricture that only permitted passage of a 0.9 mm diameter guidewire through a retrograde manner.

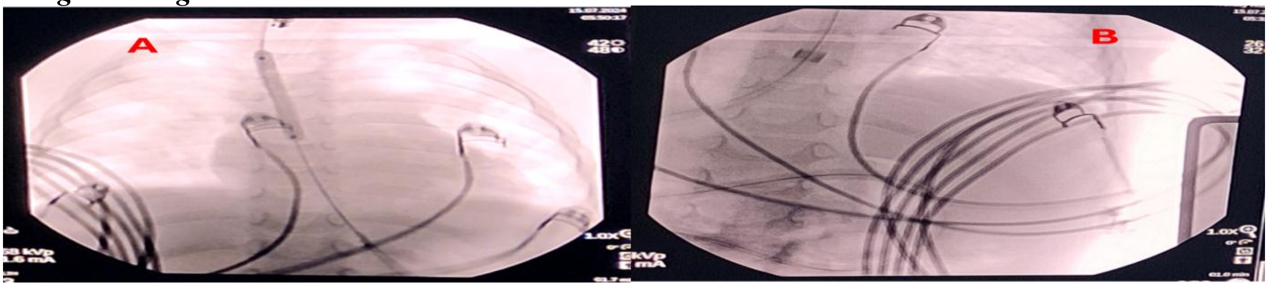

Figure (16): (A) Fluoroscopic view of balloon dilation and (B) dilation using Savary- Gilliard dilator.

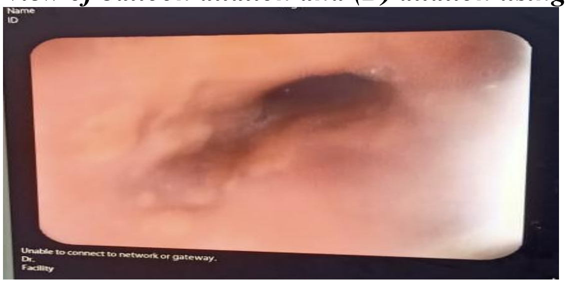

Figure (17): Endoscopic view after esophageal dilation.

DISCUSSION

Ingestion of corrosive substances remains a common problem in developing countries. Although proper therapy during the acute phase can reduce tissue damage, inadequate treatment of acute corrosive injuries is common due to clinicians' limited knowledge of the condition. Patients with acute corrosive develop rapid worsening of clinical condition and require supportive management and ICU admission. Predicting which patients will require ICU admission or extended care could improve outcomes and minimize budget waste ***(Pellathy et al., 2021)***. There is a paucity of research detecting the pattern, indication of ICU admission, and long-term follow-up patients with acute corrosive substances. Hence, this study aimed to identify patterns, indicators of ICU admission in acute corrosive poisoning, and endoscopic findings in patients who developed strictures.

The total number of admitted corrosive patients during the study period was 7.9 % of all admitted poisoned patients between September 2023 and September 2024. Among the included patients, the highest percentage of corrosive patients occurred in April and June 2024. According to the report from Zagazig University Poisoning Treatment Unit, corrosive agents were involved in 9.8% of the poisoning cases recorded throughout the year ***(Khayal et al., 2024)***.

In Benha Poisoning Control Unit, the incidence of corrosive poisoned patients was 9.5 % of all poisoned patients in one year retrospective study ***(Ali and Abo El Wafa, 2020)***. We thought that could be attributed to the Egyptian legislative framework currently lacking robust legislation governing the sale of caustic compounds. The absence of regulation is particularly concerning in the context of cleaning procedures undertaken before significant Muslim festivals, such as Eid al-Fitr and Eid al-Adha. During these periods, households frequently engage in comprehensive cleaning activities, which may involve the use of potentially hazardous cleaning products without adequate safety precautions or public awareness of the associated risks ***(Ali and Abo El Wafa,* 2020**).

The incidence of patients who were admitted to ICU was 18.6% of all included corrosive patients. According to Abdelnoor et al., the incidence of acute corrosive patients who required ICU admission was 1.8% of all the poisoned patients who were admitted to the ICU at Tanta Emergency University Hospital. Furthermore, Abdelnoor and colleagues stated that the clinical manifestations of concern leading to ICU admission included hypotension, tachycardia, tachypnea, and mixed arterial blood gas abnormalities ***(Abdelnoor et al., 2023)***.

The available research on ICU hospitalizations is limited. However, Sharif et al. (**2022**) found that 32.8% of the cases required admission to the ICU. Moreover in another study, 18% of the children required endotracheal intubation and mechanical ventilation ***(Arnold and Numanoglu, 2017)***. A separate study conducted on adults following caustic consumption indicated that 15.2% were admitted to the ICU ***(Alipour Faz et al., 2017)***. We suggested that the discrepancy in ICU admission rates between research may be attributed to the differing criteria for patient enrollment, including age, residence, and mode of exposure.

Regarding demographic characteristics, children from rural areas, through accidental poisoning were the highest incidences, especially in ICU admitted patients. ***Hollenbach et al. (2019)*** found that 60 % of their patients were females.

Meanwhile, ***Elawady et al., (2017)*** and ***Khayal et al. (2024)*** reported that males had the highest percentages. Our findings can be attributed to the continued prevalence of corrosive and detergent-based products in domestic cleaning tasks within and around the home. The sorting, removal, and disposal of household corrosives expose individuals to the risk of poisoning. Additionally, El Garbiea Governorate is regarded as one of Egypt's primary agricultural regions, where economic conditions are constrained. This context contributes to the prevalence of female-headed households, which are more susceptible to corrosive poisoning.

Among the ICU-admitted patients, the low socioeconomic level was the highest percentage. ***Hashmi et al., (2018)*** agreed with these results, as they found that the incidence of corrosive ingestion was greatly high in both less educated patients and lower socio-economic status. Furthermore, individuals with a low socioeconomic level use any detergent in the form of raw material without any dilution. These detergents are manufactured illegally without any consideration of quality standards.

In the current study, acidic corrosive substances were significantly higher than alkali and mixed corrosive ingestion. Similarly, ***Agarwal et al. (2020)*** reached similar conclusions to those presented here. The extent of the damage is contingent upon the nature of the substance (acid or alkali), its physical state (liquid or solid), and the quantity of corrosive material ingested. Except for hydrofluoric acid, the majority of acids induce coagulation necrosis accompanied by a coagulum, which restricts tissue penetration and transmural dissemination, thereby reducing the incidence of full-thickness injury. The impact of acids is more pronounced in the stomach than in the esophagus due to the development of rigid esophageal eschar and the prolonged gastric contact time resulting from pyloric spasms ***(Chirica et al., 2017)***. Conversely, in the case of alkalis, liquefaction necrosis occurs, thereby increasing the probability of transmural dissemination and resulting in damage to the periesophageal region and other organs, such as the respiratory system ***(Hollenbach et al., 2019)***.

With regard to clinical symptoms, it was observed that the prevalence of vomiting, stomach discomfort, hematemesis, and respiratory distress was significantly higher in ICU patients than in non-ICU admitted patients. The most prevalent symptom observed in individuals with corrosive poisoning was vomiting ***(Demirören et al., 2015)***.

Additionally, there was a significant association between vomiting and salivary drooling and severe esophageal lesions. In cases where small lesions were observed during endoscopy, subsequent progression to major esophageal injury was noted. Salivary drooling and stridor were identified as indicative of significant esophageal damage ***(Sharif et al., 2022)***. Conversely, research indicated that 70% of individuals with severe oropharyngeal lesions did not have substantial esophageal or stomach post-corrosive burns. Consequently, injuries to the oropharynx are not a reliable indicator of subsequent damage to the esophagus or stomach ***(Gharib et al., 2016)***. The presence of prolonged dysphagia and drooling (lasting between 12 and 24 hours) has been demonstrated to be an accurate predictor of esophageal scar formation ***(Simonovska et al., 2023)***.

Bonnici et al. (2014) asserted that any indication of vomiting, drooling, dysphagia, or pain necessitated an endoscopy, with heightened vigilance in younger patients due to the potential for significant harm to the upper gastrointestinal tract.

Concurrent occurrence of two or more clinical signs from the trio (i.e., vomiting, drooling, and stridor) in persons with a history of caustic substance consumption has been shown to reliably indicate esophageal injury in previous studies. Furthermore, individuals who present with two or more signs and symptoms subsequent to caustic chemical ingestion are predisposed to an elevated risk of complications, including esophageal stricture. This heightened risk can be attributed to the phenomenon of re-exposure of the esophagus to corrosive agents, resulting from vomiting, which can lead to exacerbation of existing damage and an augmented risk of aspiration ***(Tosca et al., 2021; Di Maggio et al., 2022)***.

Hematemesis may serve as an indicator of potential esophageal stenosis and stricture; however, it is not necessarily associated with the severity of initial esophageal damage **(Gharib et al., 2016**). Hematemesis indicates a significant injury to the esophagus and stomach, even in the absence of an oropharyngeal lesion ***(Simonovska et al., 2023)***.

The likelihood of substantial damage increases in direct proportion to hematemesis. Thus, hematemesis is significantly associated with reduced hemoglobin levels in cases of caustic poisoning ***(Chalapathi Rao et al., 2014)***.

Respiratory distress may result from the aspiration of caustic chemicals into the tracheobronchial tree, leading to respiratory injury, or from hyperventilation associated with the severity of acidosis ***(Kalayarasan et al., 2019)***. Respiratory distress was significantly associated with adverse outcomes, demonstrating high sensitivity and specificity in predicting stricture or stenosis formation 21 days post-ingestion ***(Gangakhedkar et al., 2020)***.

Conversely, a multitude of investigations have demonstrated that the clinical manifestations of corrosive ingestion are inadequate indicators of the extent and severity of esophageal or gastric injury. Furthermore, it has been determined that indications and symptoms do not consistently align with the degree of corrosive poisoning ***(Hall et al., 2019; Gangakhedkar et al., 2020)***.

The results of this study showed a significantly relative reduction in blood pressure and elevation in heart rate among ICU-admitted patients compared to those not admitted to the ICU. The primary contributors to hypovolemia and rapid circulatory compromise in cases of caustic poisoning are hematemesis, emesis, and third space sequestration, particularly in pediatric patients ***(Elawady et al., 2017)***.

The resulting hypovolemia and dehydration promote anaerobic metabolism and acidity, which are further exacerbated by hypoperfusion and hypoxia ***(Dalus et al., 2013)***.

Moreover, the present study demonstrates a noteworthy increase in body temperature among patients admitted to the ICU. Furthermore, the univariate analysis identified tachycardia, fever, and hypotension as significant indicators of ICU admission. Similarly, ***Sharif et al. (2022)*** indicated that fever and total leukocytosis were predictive factors. Prolonged fever may indicate perforation and significant tissue injury, which is primarily accompanied by inflammatory responses and subsequent infections of the impacted tissues ***(Di Maggio et al., 2022)***.

Concerning outcomes, no reported deaths during the study periods. The duration of steroid use was significantly prolonged in ICU-admitted patients compared to non-ICU-admitted patients. Recent studies have reached a consensus that suggests a degree of caution should be exercised when considering the use of corticosteroids for corrosive esophageal injuries ***(Pelclová and Navrátil, 2005; Sheikh et al., 2024)***. While there is evidence that they may be safe for certain grades of injury, current findings indicate that they are ineffective in preventing stricture formation and may pose additional risks in more severe cases ***(Usta et al., 2014)***. Consequently, many clinicians recommend against their routine use in managing corrosive ingestions, particularly for higher-grade injuries.

The need for endotracheal intubation, mechanical ventilation, and tracheostomy tube insertion was significantly low (2.9%) of all corrosive participants. Likewise, research indicates that only a small percentage of patients with caustic ingestion require immediate endotracheal intubation and mechanical ventilation. Specifically, studies demonstrate that only approximately 8% of patients necessitated these interventions due to respiratory distress upon admission ***(Kalayarasan et al., 2019)***.

This low incidence suggests that the protective mechanisms of the upper airway are often effective in preventing corrosive substances from reaching the lower airway ***(Contini and Scarpignato, 2013)***.

The tracheostomy procedure is typically indicated for patients requiring prolonged mechanical ventilation or exhibiting substantial airway obstruction. In cases of acute corrosive exposure, tracheostomy may be indicated in the presence of substantial laryngeal damage or when prolonged ventilation is anticipated. However, the necessity for tracheostomy in these instances remains minimal, with only a limited percentage of patients requiring this intervention ***(Terragni et al., 2014; Lee and Wilson, 2021)***.

Patients with a Grade 1 injury should be observed for a period of 48 hours, during which time they should be managed with careful attention to acid suppression and an oral diet, provided that painless swallowing of saliva is absent. Patients with Grade 2 and 3 injuries were admitted to the ICU, underwent resuscitation, and were maintained nil per os, with nutrition provided by gastrostomy or jejunostomy. Immediate surgical intervention and excision of necrotic organs are required for patients with Grade 4 injuries. These patients are at elevated risk and require monitoring in the ICU, mandatory ventilation, and resuscitation. In the chronic phase, the most common late complication is the formation of strictures. Such manifestations typically occur between three and eight weeks, or as late as one year thereafter ***(Di Maggio et al., 2022)***.

In the current study, patients with corrosive injury were followed up for the development of stricture formation. Upper GI endoscopy was avoided between 5 and 15 days after ingestion due to the increased risk of iatrogenic perforation. After one-month post-corrosive intake, patients with strictures were evaluated by endoscopy and properly dilatated of the strictures. The incidence of stricture formation was 17.1% of all patients with corrosive poisoning, especially in patients admitted to the ICU. Similarly, 7-15% of children experienced gastrointestinal stricture formation after ingestion of corrosive substances ***(Uygun et al., 2012)***.

Sharif et al. (2022) reported that 10% of caustic cases resulted in esophageal injury with adverse outcomes. There is a lack of studies showing the follow-up of patients with corrosive and determining the incidence of stricture formation in Egypt. This could be due to the long-term healing phase of corrosive that needs long-term follow-up study.

The healing process of tissue injury resulting from the ingestion of corrosive substances occurs in three distinct phases. The initial phase, which is characterized by cellular necrosis, persists for a period of 24 to 72 hours. The second phase is characterized by mucosal sloughing, accompanied by ulceration and fibroblast colonization. Granulation occurs over a period of three to twelve days. A stricture may form as a consequence of the healing process, which involves scarring. It is advisable to refrain from invasive diagnostic procedures, such as endoscopy, or therapeutic techniques, including dilation or stenting, during this interval. Phase three begins approximately three weeks after the initial injury and persists for three to six months or longer ***(Hollenbach et al., 2019)***.

In addition, the primary limitation of endoscopy is its inability to accurately assess the depth of necrosis, which may result in ineffective surgical intervention or inappropriate nonsurgical management, negatively impacting survival. In addition, endoscopic grading relies on the judgment of the observer. In order to surmount the constraints imposed by endoscopy, a proposal has been put forth that entails the implementation of a grading system for corrosive injury that is based on the use of contrast-enhanced computed tomography (CT) ***(Chirica et al., 2017; Kalayarasan et al., 2019)***.

Among the studied patients afflicted with corrosive poisoning, four patients underwent surgical intervention in the form of jejunostomy or gastrostomy. Such surgical procedures are often imperative for patients afflicted with severe damage resulting from corrosive ingestion. These procedures are typically performed until the gastrointestinal tract can be restored to normal function ***(Javed et al., 2012)***.

Limitations of the study

There is a paucity of research discussing the patterns and indications for ICU admission in patients with acute corrosive exposure. This study is the first to address these issues. In addition, the follow-up of these patients highlights the endoscopic findings in patients with stricture formation. These findings may assist physicians and health authorities in providing clinical guidance on ICU admission and follow-up criteria for patients with acute corrosive poisoning.

However, the smaller sample size of ICU-admitted patients may also affect the generalizability of the findings, particularly for predicting outcomes associated with severe cases requiring ICU care. In addition, the unequal sample sizes between the ICU-admitted group (n=13) and the non-ICU-admitted group (n=57) may introduce potential bias in the results and limit the statistical power to detect significant differences between the groups. Future studies with larger and more balanced sample sizes are needed to validate these findings.

CONCLUSION

The current study revealed that the prevalence of acute corrosive poisoning is 7.9% of all patients admitted to TUPCC over one year. Furthermore, the incidence of ICU admission is 18.6% of all corrosive patients. The ingestion of acid-corrosive substances, the presence of symptoms such as vomiting, abdominal pain, hematemesis, and respiratory distress as well as the presence of fever, tachycardia, lower systolic and diastolic blood pressure, pharyngeal lesions, and esophageal stricture are significant indicators of ICU admission. The endoscopic assessment after one month of post-corrosive ingestion revealed the presence of esophageal and/or gastric strictures in 17.1% of the studied corrosive patients. Endoscopic dilatation has been demonstrated to result in better outcomes with regard to stricture improvement and general condition.

RECOMMENDATIONS

- It is recommended that physicians should notice symptoms indicative of acid-corrosive intake, including vomiting, abdominal pain, pharyngeal involvement, hematemesis, and esophageal stricture, as indicators of ICU admission.
- Vital signs, including temperature, pulse, and blood pressure are significant indicators of ICU admission in patients with corrosive injuries. It is strongly recommended that prospective studies be conducted on a larger number of patients at different poison control centers. The objective of these studies would be to standardize the criteria for ICU admission in different settings and to gain a better understanding of the effects of other types of toxic exposure.
- The validation of the results of this study will significantly aid the admitting physician in making an informed decision regarding the patient's admission. It is of the utmost importance to prioritize patients according to their requirements for intensive care unit admission and susceptibility to esophageal injuries to ensure the preservation of lives and resources.
- It is recommended that greater attention be paid to the safety of preschool children, to limit their access to household corrosive substances and thus reduce their exposure to the risk of injury.

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