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ORIGINAL ARTICLE

Is EGD Needed in all Patients after Suicidal or Exploratory Caustic Ingestions?

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Abstract

Background Caustic ingestions are relatively uncommon, but remain a significant source of morbidity. Patients with caustic injury often undergo an urgent EGD, although it is not clear if an EGD is routinely needed in an asymptomatic patient. The study has two primary objectives; 1) to determine the utility of routine EGD in asymptomatic suicidal caustic ingestions; 2) to determine if asymptomatic unintentional acidic ingestions can be managed with observation alone, similar to basic ingestions.

Methods This retrospective study, which took place at 14 hospitals in three countries evaluated all patients who presented with a caustic ingestion between 2014–2020. The presence of symptoms and esophageal injury, demographic information, pH of ingested substance, reason for the ingestion, and outcome were recorded.

Results 409 patients were identified; 203 (46.9%) were male. The median (IQR) age was 18 (4–31) years; overall range 10 months to 78 years. Suicidal ingestions accounted for 155 (37.9%) of cases. Dysphagia or dysphonia were more likely in those with significant esophageal injury compared to those without (59.3% vs. 12.6% respectively; OR 10.1; 95% CI 4.43–23.1). Among 27 patients with significant esophageal injury, 48% were found in suicidal patients, compared with 51.9% in non-suicidal patients (p = NS). On multivariate regression, there was no difference in the rate of significant esophageal injury among suicidal vs. non suicidal patients (aOR 1.55; p = 0.45, 95% CI 0.45–5.33). Most ingestions involved basic substances (332/409; 81.2%). Unknown or mixed ingestions accounted for 25 (6.11%) of the ingestions. Significant esophageal burns were found in 6/52 (11.5%) of acid ingestions, compared with 21/332 (6.3%) of basic ingestions. Of the 42 cases of acidic ingestions without dysphagia or odynophagia, 2 (4.8%; 0.58–16.1%) had significant esophageal burns, compared with 9 (3.2%; 95% CI 1.4–5.9%) of the 284 basic ingestions; p = 0.64). On multivariate logistic regression, patients with acidic ingestions were not more likely to experience a significant burn (aOR 1.7; p = 0.11, 95% CI 0.9–3.1) compared to those with basic ingestions. No patient with significant esophageal burns was asymptomatic.

Conclusion In this study, there was no statistical differences in the rates of significant burns between acidic and basic caustic ingestions. There were no significant esophageal injuries noted among asymptomatic patients.

Keywords Caustic · Ingestion · Acid · Base · Esophageal burn

Background

Caustic ingestions can result in significant injury to the gastrointestinal tract, including the stomach and esophagus. Patients may encounter caustic substances in a variety of settings. Pediatric patients may encounter a caustic ingestion as the result of an exploratory ingestion, in which the patient drinks the substance under the misguided belief it is an edible liquid. Adults may consume caustic agents either intentionally (e.g. suicide attempt) or unintentionally [1]. Both types of ingestions can result in significant morbidity or mortality across multiple age groups. [1, 2]

Caustic agents are commonly classified dichotomously as acids or bases. In general, those agents at the ends of the spectrum (pH 0–2 or 12–14) are more likely to cause significant harm than those with a pH of 3-11. [3, 4] Classically alkali ingestions are associated with liquefactive tissue necrosis and acidic ingestions are associated with coagulative tissue necrosis. Liquefactive necrosis causes dissolution of tissue more quickly than

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coagulative necrosis and infiltrates tissue to cause deep tissue injury. In contrast, coagulative necrosis causes damage to superficial proteins, resulting in the formation of an eschar which may prevent deeper penetration and tissue injury. Significant tissue damage can occur with either type of ingestion, however.

One of the primary concerns with caustic injuries is the development of esophageal or gastric burns. Such burns are most often classified based on the Zargar classification [4, 5]. According to this classification, burns are considered grade 0 (no injury), 1 (edema and hyperemia of the mucosa), IIa (superficial ulcerations and friability with hemorrhages, erosions, whitish membranes, or blisters), IIb (findings of 2a plus deep discrete or circumferential ulcerations), or III (deep gray or black ulcer with frank necrosis). Such endoscopic classification is prognostically important, as grade 0, 1, or IIa burns typically recover without any long-term sequelae, whereas grade IIb or III burns typically are associated with esophageal or gastric strictures, which often require long-term interventions [5]. In addition, patients with high grade esophageal burns are at increased risk of developing esophageal cancer. [6, 7]

While the prevalence of caustic injuries has fallen over the past century, such injuries remain a relatively important public health concern [3, 8]. Because caustic ingestions are relatively uncommon, most clinicians have relatively little clinical experience in their management, and often rely on published guidelines [1]. Because the concern that suicidal adults may ingest larger quantities than unintentional ingestions, thus leading to higher rates of injury, some clinicians advocate for routine endoscopy for all suicidal patients who ingest caustics [3, 9].

In addition, while previous studies involving exploratory ingestions of bases demonstrated that asymptomatic patients can be safely observed and discharged without an esophagogastroduodenoscopy (EGD), [10, 11] the literature is sparse on exploratory ingestions of acidic substances. However, given the data suggesting a difference in outcomes between the two classes, and the lack of studies demonstrating safety in acidic ingestions, some have argued for EGDs in all asymptomatic acidic, but not basic ingestions, even though basic ingestions should, in theory, be higher risk of injury [3]. This study had two aims. The primary aim is to determine the utility of routine EGD in asymptomatic suicidal patients following caustic ingestion. A secondary aim is to determine if asymptomatic unintentional acidic ingestions can be managed with observation alone, similar to what is performed following unintentional basic ingestions. The ultimate goal of this study would be to help guide safe discharge practices for asymptomatic ingestions.

Methods

Patients

This retrospective study evaluated patients who presented to participating hospitals between 1 January 2014 through 31 December 2020 were identified via search of ICD 9 [E864, 530.19, 530.4, 947 (including 947.0, 947.1, 947.2, and 947.3), and 983 (including 983.0, 983.1, 983.2, and 983.9)], or ICD 10 (T54.1, T54.2, T54.3, and T54.9) were initially included in the screening. Patients whose esophageal injury was documented to be not due to a caustic agent (e.g. erosive esophagitis, Mallory Weiss tears, etc.) were excluded. Those patients in whom the specific caustic agent or pH were not documented, were included in the overall epidemiology data, but were excluded from any analysis comparing acids to bases. Patients were included from the following cities in the United States: Los Angeles (total of five hospitals), Pittsburgh (three hospitals, including a dedicated pediatric hospital), St. Louis (two hospitals, including a dedicated pediatric hospital), and Dallas (two hospitals, including a dedicated pediatric hospital). In addition, two international sites were included; Toronto, Canada (one pediatric hospital), Qatar (one hospital). Patients were excluded if the reason for ingestion was not ascertained.

Definitions

A significant esophageal injury was defined as the presence of a grade IIb or III burn, death if the death was felt to be due to the caustic ingestion and no EGD was performed, or the presence of a perforation on CT imaging, if performed. In addition, if a patient had no EGD performed, but had follow up at least one month after the initial ingestion and an esophageal procedure was documented (e.g. esophageal stenting, esophageal dilation, etc.), then they were considered to have a significant burn even if no EGD was performed. Similarly, patients who underwent an EGD and had no injury, or a grade I or IIa injury, and those with follow up at least 1 month after the ingestion without undergoing any esophageal procedure were considered to have a non-significant esophageal injury. Burn grade was based on the Zargar classification [6]. Serious signs or symptoms were defined as the presence of dysphagia, dysphonia, persistent vomiting/inability to tolerate orals at least six hours after the exposure, or oropharyngeal lesions. Patients with subjective isolated pain but without any other above finding were not considered symptomatic. For abstraction purposes, the terms “difficulty swallowing” was considered to be the same as dysphagia, and “horse” voice or other mention of voice change was considered to be dysphonia.

Data Abstraction and Statistical Analysis

Data abstraction was performed retrospectively using standardized methods [12, 13]. Each abstractor received specific training prior to data abstraction. The abstractors were aware of the general concept of the paper, but not the specific hypothesis. Each abstractor documented the name of the product and pH, if known. If unknown, the pH was determined based on a review of the product safety information. If the product was not able to be found, and the pH was not able to be determined, the data was included in the overall epidemiology (e.g. age, sex, etc.) but was excluded from any analysis comparing acids vs. bases. If a sign or symptom was not documented it was assumed to be not present. For example, if there is no mention of any oropharyngeal exam, it was assumed there were no lesions. If there is no mention of difficulty swallowing, the patient would be coded as having no dysphagia.

Descriptive statistics for categorical data were reported using proportions with binomial exact 95% confidence intervals. Descriptive statistics for continuous data were executed after using quantile-normal plotting demonstrated non-normality. Non-normal data are reported with median and interquartile (IQR) range. Age was also examined as a categorical variable, dividing patients into the following three categories: less than 18 years, 18–64 years, and 65 years and older.

For categorial variables, analyses were performed using Pearson χ^2 or (when any cell value fell below 5) Fisher's exact test. For variables found statistically significant, or for those with *p* values approaching significance ($p < 0.1$), univariable logistic regression was performed to assess ORs and 95% confidence intervals. Kruskal–Wallis testing was used for ordinal and non-normal continuous variables. Multivariate logistic regression model evaluation included assessment of both discrimination and calibration. Univariable analysis examined age, intent (suicidal versus non-intentional), caustic type (acid versus vase), symptoms (dysphagia or dysphonia), center, and sex. After determining there was no association between gender or which center the patient presented at and risk of serious burn, the multivariable model included dysphonia and/or drooling, acid vs. base ingestion, and age category. Adjusted odds ratios are reported for the significant findings on multivariable regression.

Discrimination was assessed by calculation of the AUROC (*c* statistic), with Stata's cross-validated AUROC procedure used to assess 95% CI for AUROC. Calibration was assessed using the Hosmer–Lemeshow goodness-of-fit procedure as well as with a graphic assessment. A cluster analysis was also performed. A weighted kappa was performed to assess the inter-rater reliability between the different centers. All statistical analysis was performed using Stata 17MP (StatCorp, College Station, TX, USA).

Study Oversight

The study was approved by local institutional review boards, at each participating hospital. The need for informed consent was waived by each of the institutional review boards. All procedures were followed in accordance with the ethical standards of the responsible committee on human experimentation and with the Helsinki Declaration of 1975.

Results

During the study, a total of 409 patients were identified, with females accounting for 205 (50.1%) of all patients. Demographic information is listed in Table 1. Acidic ingestions accounted for 52 (12.7%), whereas basic ingestions accounted for 332 (81.2%) of ingestions. The pH was either not able to be determined, or involved multiple substances in 25 (6.1%). Suicidal ingestions accounted for 155 (37.9%) of cases.

Follow up data more than 30 days after the initial burn were available for 226 (55.3%) of patients. The median (IQR) duration of follow up was 18 (6–37) months, with 95% of these 226 patients having at least two months of follow up data. Either EGD results from the initial hospitalization or 30 day follow up were available for 291 (71.2%) of subjects. Among these patients with 30 day follow up available, 14 (3.4%) had an esophageal procedure documented on follow up; all except one were in patients with an initial EGD demonstrating a grade IIb or III burn. Baseline characteristics are presented in Table 2. An EGD was performed on 150 (36.7%) of all patients;

Table 1 Demographic information.

Characteristic	Total
Total patients	409
Female	205 (50.1%)
Median (IQR) age	18 (4–31) years
Age range	3 months-93 years
Age < 5 years	112 (27.3%)
5–17 years	88 (21.5%)
18–30 years	103 (25.2%)
31–65 years	88 (21.5%)
> 65 years	18 (4.4%)
Median (IQR) time between ingestion and ED presentation	1.4 (1–3) hours
Suicidal intent	155 (37.9%)
Caustic type	
Basic ingestion	52 (12.7%)
Acidic ingestion	332 (81.2%)
Unknown (or multiple)	25 (6.1%)

Table 2 Baseline clinical characteristics of patients.

Characteristic	Number (Percentage)
Dysphagia or dysphonia	64 (15.7%)
Oropharyngeal lesions	67 (16.4%)
Persistent pain	199 (48.7%)
Oral	44 (22.1%)
Chest	31 (15.6%)
Abdominal	42 (21.1%)
Multi-site	74 (37.2%)
Unspecified	8 (4%)
Vomiting	170 (41.6%)

Table 4 Acidic vs. basic ingestions.

	Acidic ingestions (n = 52)	Basic ingestions (n = 332)
Age; median (IQR) years	24 (15–34)	16 (3–30)
Male	33 (63%)	160
Dysphagia or Dysphonia	10 (19%)	48 (14%)
With significant esophageal injury	4	12
Without significant esophageal injury	6	38
Significant esophageal injury	6 (12%)	21 (6.3%)
EGD		
Grade IIb	3 (5.8%)	9 (2.7%)
Grade III	3 (5.8%)	9 (2.7%)

the results are listed on Table 3. Twenty-seven (6.6%) of patients were considered to have a serious burn, including two patients (0.5%) who died.

Age 65 or older was associated with an increase in esophageal injury on both univariable assessment (p = 0.000) with logistic regression (OR 2.9, p = 0.001, 95% CI 1.6–5.7) and multivariable regression (p = 0.0005; aOR 7.7, CI 2.5–24.0%).

Dysphagia or dysphonia were present in a total of 64 (15.7%) of subjects, including 48 of the 382 (12.6%) patients without a significant esophageal injury, and 16 of the 27 (59.3%) with a significant esophageal injury. Thus, dysphagia or dysphonia were more likely in those with significant esophageal injury than those without (OR 10.1; 95% CI 4.43–23.1). Similarly, dysphagia or dysphonia were present in 12 of 142 (8.5%) suicidal patients without esophageal injury whereas it was present in seven of 13 (53.8%) suicidal patients with esophageal injury; OR 12.6, 95% CI 3.66–43.69. Among the non-suicidal ingestions, dysphagia or dysphonia were present in 36 of the 240 (15%) of patients without significant esophageal injury, compared with nine of 14 (64.2%) of patients with significant esophageal injury (OR 10.2; 95% CI 3.23–32.2). Table 4 compares baseline characteristics and EGD results of acidic versus basic ingestions, whereas Table 5 compares baseline characteristics and EGD results based on intent. Each patient with significant esophageal injury had significant signs or symptoms, defined *apriori* as any of the following: dysphagia, dysphonia, recurrent vomiting/inability to tolerate orals, or oropharyngeal lesions.

Significant burns were found in 13 (8.4%) of the patients with suicidal intent, compared with 14 (5.5%) of the patients with unintentional ingestions; p = 0.256. Because suicidal ideations was not associated with significant esophageal injury on univariate analysis, it was removed from the logistic regression model. If the suicidal ideation was forced back into the logistic regression model with the significant covariates, (age and dysarthria or dysphagia), the aOR's was 1.55 (p = 0.45; 95% CI 0.45–5.33).

Of the 384 patients in whom acid or base identification was known, there were 332 (86.5%) basic ingestions and 52 (13.5%) acidic ingestions. Of these 52 acid ingestions, six (11.5%, 95% CI 4.3–23.4%) patients had significant esophageal injury; of the 332 base ingestions, 21 (6.33%, 95% CI 3.9–9.5%) patients had significant esophageal injury. These significant injuries included 9 patients with grade 2b esophageal burns, 9 patients with grade 3 burns, one death prior to an EGD, one patient with a grade I burn on EGD who required a subsequent esophageal procedure, and one patient with an esophageal perforation on imaging that did not have an EGD. The patient with an esophageal procedure performed with a low-grade EGD injury was complaining of significant pain and was not able to tolerate any oral liquids at 6 h, but the words "dysphagia" were not specifically

Table 3 Results of EGD.*

Grade	Number (Percentage)	Repeated vomiting	Dysphagia	Dysphonia	Oropharyngeal lesions	Intubation
No injury	48 (33.3%)	14 (29%)	5 (10%)	5 (10%)	10 (21%)	2 (4%)
Grade I	48 (33.3%)	19 (40%)	7 (15%)	6 (13%)	13 (27%)	7 (15%)
Grade IIa	24 (16.7%)	18 (75%)	6 (25%)	6 (25%)	10 (42%)	8 (33%)
Grade IIb	12 (8.3%)	8 (67%)	7 (58%)	5 (42%)	8 (67%)	2 (17%)
Grade III	12 (8.3%)	11 (92%)	3 (25%)	4 (33%)	6 (50%)	8 (67%)

*Results available for 144 of the 150 patients who underwent EGD

Table 5 Suicidal vs. non-intentional ingestions.

	Suicidal ingestions (n = 155)	Non-intentional ingestions (n = 254)
Age; median (IQR)	21 (16–30)	5 (1.8–30)
Male	62 (40%)	141 (56%)
Dysphagia or Dysphonia	19 (12%)	45 (18%)
With significant esophageal injury	7	9
Without significant esophageal injury	12	36
Significant burn	13 (8.4%)	14 (5.5%)
Acidic burns	12 (7.7%)	40 (16%)
EGD		
Grade IIb	6 (3.9%)	6 (2.4%)
Grade III	7 (4.5%)	5 (2%)

recorded in the record, so was coded as having no dysphagia. Nonetheless, that patient was not able to tolerate any orals at 6 h. Similarly, there was one patient with a possible esophageal perforation on CT that was not tolerating oral liquids at 6 h, but did not have an EGD performed during the index hospitalization, but was managed conservatively. The estimated rate of significant esophageal injury in acid ingestions (11.5%) was substantially higher than base ingestions, however, there was no statistically significant difference in esophageal injury between acids and bases on univariable assessment or multivariate analysis (aOR 1.7; p = 0.11, 95% CI 0.9–3.1), which adjusted for age, acid vs. base ingestion, and the presence of dysphagia or dysphonia.

Of the 42 cases of acidic ingestions without dysphonia or dysphagia, two (4.8%; 95% CI 0.58–16.1%) had significant esophageal burns, compared with nine (3.2%; 95% CI 1.4–5.9%) of the 284 basic ingestions; p = 0.64). Dysphonia or dysphagia was associated with an increase in significant esophageal injury in both acid ingestions (OR 13.3, p = 0.009; 95% CI 1.99–89.3) and base ingestions (OR 10.2, p = 0.000; 95% CI 4.1–25.9). In subjects without dysphonia or dysphagia, there was again no statistically significant difference between acids' and bases' risk of significant esophageal injury. Figure 1 outlines EGD serious esophageal injury and EGD results by caustic category.

There were two patients with acidic ingestions that lacked dysphagia or dysphonia, but had significant esophageal burns. One adult male had an unintentional ingestion of an acid and while he was not documented specifically as having dysphagia or dysphonia, he remained unable to tolerate orals at 6 h. The second patient, a pediatric patient with an exploratory ingestion required endotracheal intubation for significant edema. While dysphagia or dyshphonia were not documented in the records for either, and thus had to be coded as "no" for dysphagia or dysphonia based on the *apriori* definitions, neither were actually asymptomatic. There were several patients with basic caustic ingestions without dysphagia or dysphonia. All patients from both the basic or acidic groups who had significant esophageal injury met the pre-defined definition of serious signs or symptoms.

The weighted kappa statistic showed excellent correlation between abstractors.

Discussion

In this series, we opted to include a composite endpoint of esophageal intervention at 1 month, a grade 2b or 3 burn on EGD, perforation on CT imaging, or death due to the caustic ingestion to define a significant injury. It is well-established that the vast majority of grade IIb burns and virtually all grade III burns will develop strictures. The timing of

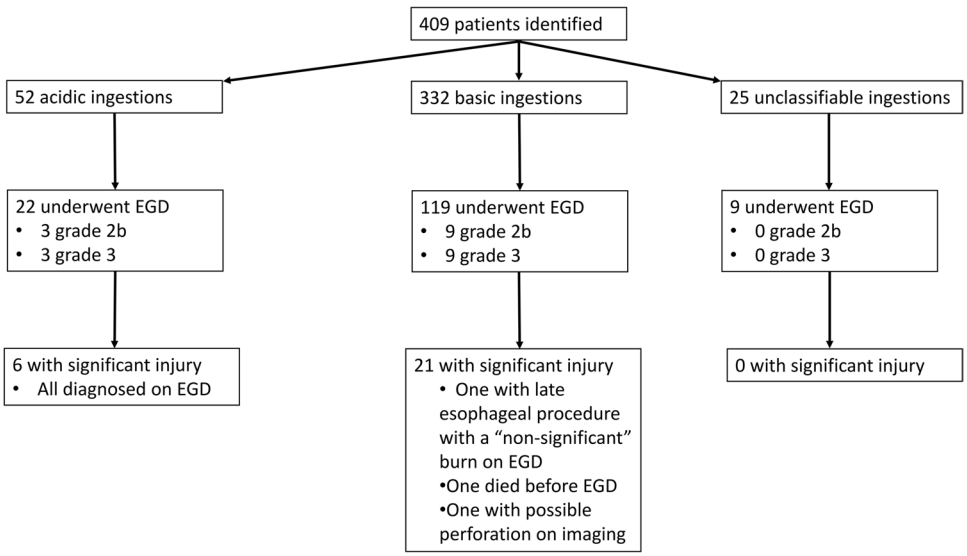

Fig. 1 Participant flow diagram.

strictures is somewhat variable, and can be seen as early as 3 weeks, but typically develops within 2 months. [14] While we opted to have one month follow up as the minimum, which might have resulted in missing some patients with late strictures, given the median duration of follow up was 18 months, and almost all had at least two months follow up, we feel this is unlikely to have resulted in missing significant number of patients. Furthermore, in many of these sites (e.g. Toronto and Doha), because of the structure of the healthcare system, it is highly unlikely patients presented outside of the tertiary care hospital for an esophageal procedure thereby further minimizing the likelihood an individual may have been missed on follow up.

All patients who developed significant burns had symptoms other than pain. Because the perception of pain is quite variable, and its assessment is subject to racial bias [15, 16], we opted to not include pain when evaluating symptoms, and rather focus on more objective measures (e.g. oropharyngeal lesions, dysphagia, etc.). Because no suicidal patient had any significant esophageal injury without concurrent other significant symptoms (e.g. dysphagia, dysphonia, oropharyngeal lesions, persistent vomiting), we feel suicidal patients who lack serious signs or symptoms can forgo urgent EGD, as long as they remain asymptomatic after a period of observation. It is possible a suicidal patient may minimize symptoms such as dysphagia and the clinician would always need to use judgement if they think the patient is minimizing symptoms. Even in this series, however, even if some patients minimized it, we still demonstrated that intent alone does not necessarily justify an EGD.

This study is limited by its retrospective nature. Consequently, the conclusions are limited by the quality and completeness of data in the medical record. It is possible that a specific caustic agent or the reason for ingestion was misidentified. While misclassifying an ingestion as intentional vs. unintentional could happen, we feel it would be rare and would not substantially alter the results of this paper. To further minimize limitations of a retrospective study, we opted to focus mostly on objective, categorical data (e.g. did the patient have an esophageal procedure or not). The choice of these variables likely minimized, if not eliminated some of the limitations inherent to retrospective studies [13], although we acknowledge several areas remain somewhat subjective. For example, there is some subjectivity in the grading of an EGD, and kappa statistics were not performed on the numerous endoscopists performing the EGD, but only on the data abstractors, thus creating a possible limitation. There were several cases where the EGD results were not able to be ascertained. While the discharge summary did not mention any significant injury, it is impossible to know for certain what, if any, injury was discovered. Thus, this missing information may alter the findings of this study. In addition, given approximately 29% did not have an EGD or 30 day follow up, it is possible some patient may have been miscategorized as having a non-significant injury.

It is also possible that this study is limited by a type II error. This study did not divide suicidal basic ingestions vs. suicidal acidic ingestions, but rather focused on suicidal vs. non suicidal ingestions. Given the near equivalence of the proportions of acids and bases involving suicidal cases, using a conventional numbers of a beta of 0.2 and an alpha of 0.05, a study restricted to suicidal cases would need to have 15,826 cases per group to have sufficient number of cases for an 80% power. Given the relative rarity of these ingestions, it would be nearly impossible to be able to have 32,000 patients identified to comfortably say a type II error did not occur. Thus, this study, which is one of the largest to date, strongly suggests suicidal patients may not need an EGD if they lack serious signs or symptoms.

This study evaluated caustic agents as acids or bases. It should be noted that some substances, such as phenol, can have significant burns despite a near neutral pH. This study did not address those rare events, but it is likely that symptoms can still dictate therapy even in those settings, but ultimately the management should of those situations should be taken on an individualized basis.

Conclusions

Acknowledging the limitations of this study, in our cohort, all patients who developed significant esophageal injury had at least one serious sign or symptom. Regardless of intent, patients did not develop serious esophageal burns in the absence of serious signs or symptoms. Furthermore, there is no difference in the rate of esophageal injury among acidic or basic ingestions. More importantly, no asymptomatic patient in this series had a clinically significant injury. Routine EGD for suicidal patients and those who ingest acids may be avoided if patients lack serious signs or symptoms after a period of observation.

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Declarations

Conflict of interest None.

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