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Original Article

Role of early endoscopic evaluation in decreasing morbidity, mortality, and cost after caustic ingestion: a retrospective nationwide database analysis

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SUMMARY. **Caustic substance ingestion (CSI) is a serious medical problem with potentially devastating short- and long-term consequences. Early upper gastrointestinal endoscopy (EaEn) is recommended to evaluate the extent of injury and guide management but there has been controversy about the timing. There is no nationwide study evaluating adherence to EaEn and outcomes following CSI.**

Nationwide Inpatient Sample database 2003–2011 was used to identify all-age, nonreferral, urgent/emergent admissions with E-International Classification of Diseases Ninth Revision codes for CSI. We evaluated the association of undergoing late endoscopy (LaEn, >48 hours since admission) with poor clinical (death or systemic complications) and economic (cost for admission and length of stay above the 75th percentile) outcomes after controlling for other demographic and clinical factors using a multivariate analysis.

We identified 21,682 patients with a median age of 37 years, 51% males, 43% Caucasians, with suicidal ingestion reported in 40%. Endoscopy was performed in 6011 patients (37%). The majority had EaEn (43% within 24, and 40% within 24–48 hours), whereas 17% had LaEn.

Compared to EaEn group, the LaEn group was associated with a three-fold increase (OR = 2.7, $P < 0.001$) in the risk for poor clinical outcome: a fourfold increase (OR = 4.6, $P < 0.001$) in high cost admissions, and a fivefold increase (OR = 4.9, $P < 0.001$) in prolonged hospitalization. There was no significant difference in clinical outcomes based on endoscopy within 24, and 24–48 hours of admission.

In this retrospective nationwide database analysis, undergoing LaEn was associated with both negative clinical and economic outcomes. More studies are needed to further examine the reasons for delaying endoscopy and subsequent management pathways based on the endoscopic findings. Early endoscopic evaluation could potentially improve the clinical outcomes and reduce costs of these admissions.

KEY WORDS: **caustic substance ingestion, cost, early upper gastrointestinal endoscopy, morbidity, mortality.**

BACKGROUND

Caustic substance ingestion (CSI) is a serious health hazard with more than 5,000 ingestions per year in the United States.[1] This can result in devastating short- and long-term consequences.[2] CSI in adults is usually associated with a suicidal attempt, whereas in children this is commonly accidental in nature. The former tends to be more severe with larger volumes of caustic substance ingested.[3–5] The extent of tissue injury depends on the physical properties of the chemical ingested: solid or liquid form, acidic or basic type (pH level <2 or >12), concentration, duration of contact, and amount of substance ingested.[6,7]

Performance of an upper gastrointestinal (UGI) endoscopy is the most commonly accepted procedure that can safely assess the depth and extent of caustic substance injury. Information from the

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UGI endoscopy can influence subsequent therapy. Several aspects of patient management postingestion remain controversial: performance of an UGI endoscopy for all patients, optimal timing of the UGI endoscopy, classification or grading of mucosal injury, and postingestion medical management.[2,6–9]

Signs and symptoms often do not correlate with the degree of internal injury and therefore early endoscopic evaluation is recommended for most if not all patients.[10,11] Gupta *et al*. have suggested that an UGI endoscopy may not be necessary for asymptomatic patients with alleged caustic ingestion.[2,12] The timing of UGI endoscopy is controversial. In the past, the recommendation was to wait at least 24 hours to allow time for the injury to mature,[13] recently Cheng and Lin recommend an UGI endoscopy within 12 to 24 hours of ingestion.[6] Endoscopy past 48 hours is discouraged based on a concern for progressive weakening of the gut wall, leading to an increased risk of perforation.[14]

Currently, there have been no published reports about the nationwide epidemiology, performance of EaEn versus LaEn, clinical and economic outcomes following CSI across all age groups. Our aim is to use a nationwide database to evaluate caustic injury management and outcomes in the United States.

METHODS

Study population

Data from the Nationwide Inpatient Sample (NIS) 2003–2011 were obtained. The NIS is a component of the Healthcare Cost and Utilization Project (HCUP),[15] sponsored by the Agency for Healthcare and Quality. This database represents the largest inpatient database in the United States. The NIS represents a 20% stratified sample of approximately 95% of US hospitals including public hospitals, children's hospitals, and academic medical centers. The database contains data from more than a thousand hospitals with more than eight million discharges annually from 44 states.

Inclusion criteria

We identified all-age, nonreferral, urgent/emergent admissions with International Classification of Diseases Ninth Revision (ICD9) E codes indicating caustic ingestion. The "E" codes denote external causes of injury or poisoning. The following codes were used to identify accidental ingestion: E861.0 through E861.4, E864.0 through E864.4, and E980.6. Suicidal ingestion was identified by the codes E950.7 and E958.7. Our inclusion codes were adopted with modification from a prior report, which used ICD9 E codes in identifying CSI hospitalization from the HCUP databases.[16]

Endoscopic evaluation

Performance of an UGI endoscopy for a patient postingestion was identified based on the presence of the appropriate ICD9 procedure codes. The codes used in identifying these procedures have been previously used in other studies that utilized the NIS database.[17–20] The timing of an UGI endoscopy was classified into three groups based on the time of endoscopy after admission: <24 hours and 24–48 hours (defined as Early Endoscopy or EaEn group) and >48 hours (defined as the Late Endoscopy or LaEn group). Patients who did not undergo endoscopic evaluation during the hospital stay were not included in the evaluation of outcomes.

Caustic ingestion complications and hospital course

We identified potential complications of caustic ingestion based on selected ICD9 codes (Appendix). Local complications that were identified included gastrointestinal bleed, tracheoesophageal fistula, and perforation (as identified by the occurrence of any of the following: esophageal perforation, gastric perforation, intestinal perforation, pneumomediastinum, pneumoperitoneum, mediastinitis, and peritonitis).[6,21]

Systemic complications that were identified included shock, sepsis, aspiration pneumonia, acute renal failure, hemorrhage (identified by the hemorrhagic anemia diagnosis code or the need for blood transfusion), hemolysis, acute hepatic necrosis, disseminated intravascular coagulation (DIC), and late respiratory failure.[6,21]

We identified the occurrence of late intubation and mechanical ventilation (= or > than 48 hours after admission) as an adverse event in our analysis since this is most likely secondary to respiratory failure complications following CSI as compared to early intubation that might have been done for airway protection.

Using the appropriate ICD9 procedures codes, we identified the need for surgical intervention (esophagectomy, gastrectomy, laparotomy, laparoscopy, thoracotomy, thoracoscopy, and interposition of colon or small bowel to replace the esophagus) during the hospitalization following CSI.

Other identified data analyzed

Other demographic variables (age, sex, and race), geographic area (West, Northeast, Midwest, and South), insurance (private, Medicare, Medicaid, others), median house hold income quartile (based on the address ZIP code, provided by the HCUP), day of admission (weekend vs. not weekend), and hospital characteristics (teaching status and location: urban versus rural) were also identified.

Comorbidities were summarized using the Charlson comorbidity index (CCI) score. Patients were classified into two groups 0–1 and >1.[22] The CCI is a global measure of comorbidities that are calculated for patients according to the presence of four atherosclerotic comorbidities (peripheral arterial disease, myocardial infarction, cerebrovascular disease, and congestive heart failure), and 13 nonatherosclerotic comorbid conditions (diabetes mellitus with and without complications, chronic lung disease, gastrointestinal ulcer, arthritis, paraplegia, chronic renal failure, malignancy with and without metastasis, acquired immunodeficiency syndrome, dementia, liver disease, and liver failure). CCI has been extensively used and validated in administrative databases.[23–25]

Cost and length of stay analysis

Hospital-related charges for each admission were converted to the organizational cost of providing care per case using cost-to-charge ratios provided by Agency for Healthcare Research and Quality (AHRQ) for individual hospitals.[26] Costs were then adjusted to 2015 US Dollars using data from the U.S. Bureau of Labor Statistics.[27] Weighted medians and interquartile range (IQR) were calculated for inpatient hospital costs based on the timing of endoscopy. We then identified hospitalizations that were associated with costs above the 75th percentile as high cost admissions and used costs from these hospitalizations as the dependent variable in the cost analysis.

Length of stay (LOS) is provided by AHRQ in the NIS database. Prolonged hospitalization was defined as LOS above the 75th percentile. Admissions with prolonged LOS were identified and used as an outcome in the multivariate analysis.

Outcomes

The rates of poor clinical and economic outcomes were compared among the three groups based on the time interval to an upper endoscopy following CSI (<24 hours, 24–48 hours, and >48 hours). Poor clinical outcome was defined as the occurrence of any of the following: in-hospital death, tracheostomy, parenteral nutrition, gastrostomy (feeding tube placement), and/or systemic complications described earlier. Poor economic outcomes were defined in two ways. First, admission for CSI was considered a high cost hospitalization using the cutoff value of admissions costing above the 75th percentile of all admissions in the database. Second, an admission was considered a prolonged hospitalization using the cutoff value above the 75th percentile duration of hospital stay for all admissions. We also identified variables, which occur more frequently among patients, undergoing LaEn (>48 hours after admission) by analyzing the patient clinical and demographic data as well as hospital characteristics.

Statistical analysis

Univariate analysis was performed to identify potential associated variables with our stated outcomes using the Chi square, Fisher Exact, and student t test when appropriate. Age was classified into <18, 18–40, 40–65, and > and = 65 in the multivariate models. Variables that achieved statistical significance in the univariate analysis with p value <0.05 were included in a multivariable logistic regression analysis with backward stepwise selection of the variables (Appendix). We used the Boneferroni correction to account for multiple comparisons to our predictor models. For the multivariate analyses, the significance threshold was <0.003. Data were analyzed by using the SAS software, Version 9.3 for Windows (SAS Institute Inc., Cary, NC, USA), licensed to University of Florida. We took into account the samplings weights provided with the NIS database when performing the analysis.

In order to adjust for nonrandom allocation of endoscopy timing, we calculated the propensity scores of undergoing UGI endoscopy at certain time intervals and included them as part of the multivariate logistic regression analysis to predict poor clinical outcomes.[28] The time to endoscopy <24 hours' propensity score evaluation was not included in the model and, thus, acted as a reference group.

Propensity scores are the conditional probabilities of undergoing endoscopy <24 hours, between 24–48 hours, and >48 hours based upon patients' and the admissions' identifiable factors such as demographics, comorbidities, and hospital characteristics.[28,29] Including the propensity scores in the multivariate analysis helps reduce the selection bias in deciding the timing of endoscopy.[28,29] This, in turn, will improve the validity of the calculated effect size of LaEn on the studied outcomes.

Ethical considerations

The NIS database consists of completely de-identified data with minimal or no risk of loss of confidentiality. An exemption from review was received after corresponding with the Institutional Review Board at the University of Florida. We completed a data user agreement with the AHRQ before using the NIS database.

RESULTS

We identified 21,682 patients (the unweighted sample size was 4,404) with a median age of 37 years (IQR: 21–54). Males represented 51% of the identified patients and Caucasians represented 43% of these

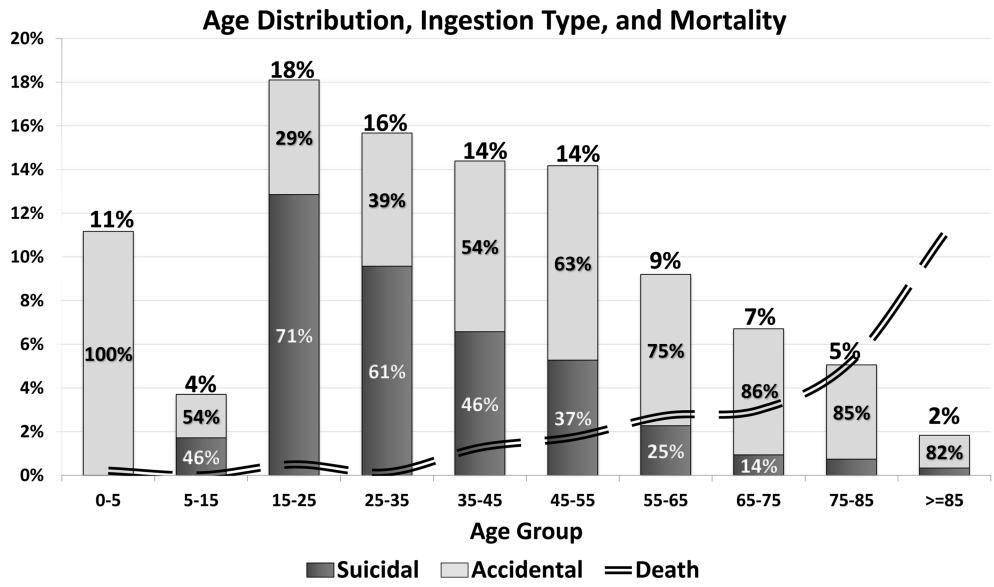

Fig. 1 Age distributuion, ingestion types, and mortality after caustic ingestion injuries. The bar height represents the prevalence across each age group, the color break down represents accidental versus suicidal ingestion. The double line represents death rate across each age group.

patients. Suicidal ingestion was reported in 40% of the cases with the remaining being accidental in nature. There were two peaks of incidence, <5 years old with 100% accidental CSI and age 15–25 years old with 71% suicidal CSI. Overall, the mortality rate was 1.5% with significant increase among those >85 years of age to 11% ($P < 0.001$) (Fig. 1).

UGI endoscopy was performed in 6,011 patients (37% of all identified caustic ingestion admissions). The majority of these were performed within 48 hours of admission (43% within 24, and 40% between 24 to 48 hours), whereas 17% of UGI endoscopy were performed after 48 hours and thus classified as LaEn. Only patients who underwent endoscopic evaluation were included in the multivariate analyses listed below.

Factors associated with poor clinical outcome

Overall, 787 patients (13%) were classified to have poor clinical outcomes as defined in the methods section. Patients who underwent LaEn had significantly higher prevalence of poor clinical outcomes (>48 hours, 30%), compared to those who underwent EaEn (<24 hours and 24–28 hours, had 11% and 9% respectively), $P < 0001$. Comparing the individually studied factors categorized as poor outcome between the EaEn versus the LaEn group demonstrated a similar pattern as shown in Figure 2.

Using a multivariate analysis, having LaEn was associated with a three-fold increase (OR 2.7, 2.2–3.3, $P < 0.001$) in the prevalence of the aforementioned poor clinical outcomes compared to EaEn. This association persisted after adjusting for the nonrandom selection of the patients for EaEn versus LaEn using propensity scores. Other factors that showed significant association with poor clinical outcomes included older age, male gender, higher comorbidities, presence of local complications, and the need for surgical intervention (Table 1).

Factors associated with high cost

Median cost of caustic injury admission was $4,860 (IQR $3,188–$9,483) 2015 US Dollars. Admission costs above $9,483 (>75th percentile) were considered higher cost admissions. The median cost of admissions that had EaEn was $4,277 (IQR $2,939–$7,750) compared to a median of $10,524 (IQR $6,050–21,600), $P < 0.001$, for admissions with LaEn. Nineteen percent of admissions with EaEn were classified as higher cost compared to 56% among admissions with LaEn, $P < 0.001$.

Using a multivariate analysis, LaEn was associated with a four-fold increase in the prevalence of a higher cost admission (OR 4.6, 95%CI 3.9–5.4, $P < 0.001$) compared to EaEn. Other factors that were associated with higher cost admissions mirrored those of poor clinical outcomes as shown in Table 2.

Factors associated with prolonged length of stay

Median LOS following a caustic ingestion injury admission was 2 days (IQR: 1–5); those with a LOS above 5 days (>75th percentile of duration of admission) were considered prolonged LOS admissions. The median LOS or duration of admission for the EaEn group was 2 days (IQR: 1–4) compared to a median of 6 days (IQR: 3–12), $P < 0.001$, for LOS duration in the LaEn group. Twenty percent of admissions with

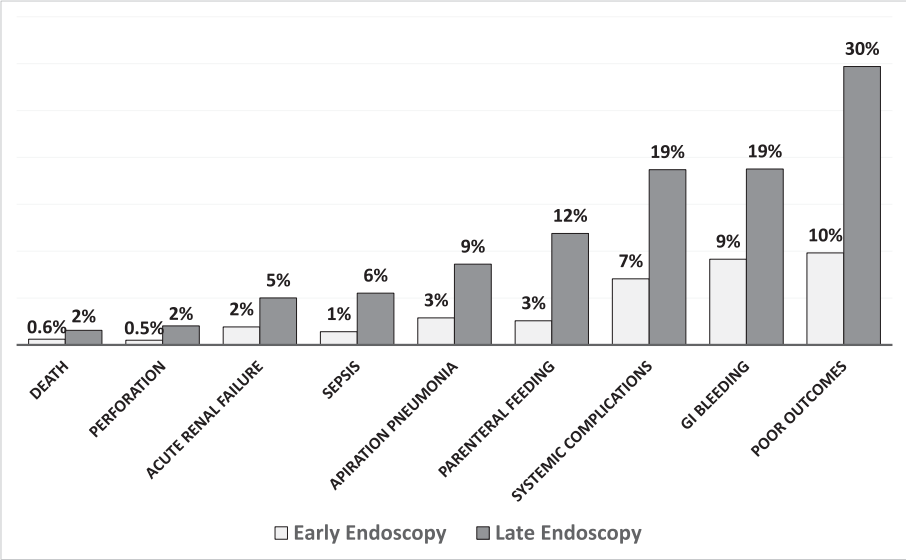

Fig. 2 Poor clinical outcomes by endoscopy timing. The bar height represents the prevalence of occurrence of these outcomes across endoscopy time groups.

Table 1 Multivariate analysis of the factors associated with poor clinical outcomes

		Total #	Outcome #	%	OR	LCI	UCI	*p*
Age	<18	1688	112	7%				
	18–40	2188	213	10%	1.1	0.9	1.5	0.317
	40–65	1645	307	19%	2.2	1.7	2.7	<0.001
	=>65	490	155	32%	4.1	3.0	5.6	<0.001
Gender	Female	2607	304	12%				
	Male	3404	484	14%	1.4	1.2	1.6	<0.001
Race	Caucasian	2541	395	16%				
	AA	1409	158	11%	0.7	0.6	0.9	0.002
	Hispanic	804	112	14%	1.0	0.8	1.3	0.838
	Asian	155	31	20%	1.7	1.1	2.7	0.015
Charlson comorbidity index	0–1	5595	670	12%				
	2 and above	416	117	28%	1.4	1.1	1.9	0.002
Local complications	No	5335	598	11%				
	Yes	676	189	28%	2.3	1.9	2.9	<0.001
Surgery	No	5942	754	13%				
	Yes	69	34	49%	4.1	2.4	7.0	<0.001
Upper endoscopy timing	<24 hours	2593	278	11%				
	24–48 hours	2421	214	9%	0.9	0.7	1.0	0.131
	= or >48 hours	997	296	30%	2.7	2.2	3.3	<0.001
Upper endoscopy timing, Propensity scores adjusted	<24 hours	2593	278	11%				
	24-48 hours	2421	214	9%	0.9	0.7	1.1	0.233
	= or >48 hours	997	296	30%	2.8	2.3	3.4	<0.001

Upper endoscopy timing is in relation to admission time. Significant *p* value is less than 0.003.
Abbreviations: #, number of patients; AA, African American; LCI and UCI, the lower and upper limits of 95% confidence interval of the OR; OR, odds ratio; *p*, *p* value.

EaEn were classified as prolonged LOS compared to 59% among admissions with LaEn, $P < 0.001$.

Using a multivariate analysis, LaEn was associated with a five-fold increase in the prevalence of a prolonged LOS admission (OR 4.9, 95%CI 4.2–5.8, $P < 0.001$) compared to EaEn. Other factors that were associated with prolonged LOS mirrored those of poor clinical outcomes and higher costs as presented in Table 3.

Factors associated with late endoscopy

The main factors that were associated with undergoing LaEn were older age (>65 vs. <18, OR 4.2, $P < 0.001$), high comorbidity (Charlson comorbidity index of 2 or above versus 0–1, OR 1.8, $P < 0.001$), weekend admissions (OR 1.6, $P < 0.001$), and admission to nonteaching hospitals (OR 1.3, $P < 0.001$) (Table 4).

Table 2 Multivariate of the factors associated with high cost admissions

		Total #	High cost #	%	OR	LCI	UCI	*p*
Age	<18	1688	270	16%				
	18–40	2188	436	20%	1.1	0.9	1.4	0.366
	40–65	1645	546	33%	1.9	1.5	2.4	<0.001
	=>65	490	246	50%	2.4	1.7	3.3	<0.001
Gender	Female	2607	602	23%				
	Male	3404	903	27%	1.3	1.1	1.5	<0.001
Race	Caucasian	2541	686	27%				
	AA	1409	302	21%	0.7	0.6	0.9	0.002
	Hispanic	804	220	27%	1.2	1.0	1.5	0.121
	Asian	155	53	34%	1.9	1.3	2.9	0.001
Insurance	Private	1606	355	22%				
	Medicare	890	421	47%	1.8	1.4	2.3	<0.001
	Medicaid	1817	428	24%	1.2	1.0	1.4	0.061
Teaching status of hospital	Nonteaching	2140	463	22%				
	Teaching	3803	1028	27%	1.9	1.6	2.2	<0.001
Charlson comorbidity index	0–1	5577	1269	23%				
	2 and above	415	231	56%	2.3	1.8	2.9	<0.001
Caustic Ingestion Type	Accidental	3043	677	22%				
	Suicidal	2949	823	28%	1.4	1.2	1.6	<0.001
Local complications	No	5316	1169	22%				
	Yes	676	331	49%	2.5	2.0	3.0	<0.001
Systemic complications	No	5471	1108	20%				
	Yes	540	395	73%	7.6	6.0	9.5	<0.001
Surgery	No	5942	1447	24%				
	Yes	69	58	84%	11.0	5.3	22.7	<0.001
Upper endoscope timing	<48 hours	5014	944	19%				
	= or >48 hours	997	562	56%	4.6	3.9	5.4	<0.001

Upper endoscope timing is in relation to admission time. Significant *p* value is less than 0.003.
Abbreviations: #, number of patients, AA, African American; LCI and UCI, the lower and upper limits of 95% confidence interval of the OR, OR, odds ratio; *p*, *p* value.

DISCUSSION

To our knowledge, this is the first study in the United States reporting both clinical and economic outcomes of admissions following CSI. There were almost 2,000 admissions per year over the investigated 9-year time frame. For those patients who underwent an upper endoscopy following CSI (37%) adherence rate to the recommendation for EaEn was 83%. LaEn was associated with a three-fold increase in the risk of poor clinical outcomes, a four-fold increase in the rate of high cost admissions, and a five-fold increase in the rate of prolonged hospitalization. Older age, high comorbidities, and nonteaching hospitals, or weekend admissions were associated with higher rate of receiving LaEn.

A wide spectrum of injuries can occur due to ingestion of caustic material depending on the duration of exposure, type of ingested agent, concentration of the caustic substance, and volume ingested. After resuscitation, there is an urgent need to define the severity, location, and extent of injury.[30] To some extent, the location and severity caustic substance injury can be based on clinical signs and symptoms. Even though these clinical symptoms can provide useful information, they might not correlate with the extent of internal injury.[4,10,11,31] Examples of these clinical features: aphonia, stridor or hoarseness may indicate injury to the larynx; location specific pain may indicate mucosal injury to the mouth, esophagus or stomach; hematemesis may indicate mucosal injury to any of the above organs.[32]

Radiographic imaging studies can provide useful information regarding damage to the GI tract and adjacent structures, but they do not accurately assess the degree, location, and extent of injury.[33] Therefore, EaEn is essential in a more accurate picture of CSI depth level extent of injury.[31,34] The role of endoscopic evaluation has changed considerably over the years. In the past, a high perforation rate might have happened due to the use of rigid endoscopes.[4] With today's thinner caliber flexible endoscopes, a careful and gentle examination is generally considered practical, simple, and safe.[4]

Some controversy remains over the use of EaEn in caustic substance injuries because it is an invasive procedure and there have been no studies definitively showing that it influences outcomes in such injuries.[35] Prior reports have shown that endoscopy can be safely undertaken from 6 and up to 96 hours after CSI.[4] There is increased risk or danger of perforation in the subacute phase (5–15 days after ingestion) during

Table 3 Multivariate analysis of the factors associated with prolonged length of stay

		Total #	Pro LOS #	%	OR	LCI	UCI	*p*
Insurance	Private	1606	394	25%				
	Medicare	890	421	47%	1.9	1.6	2.4	<0.001
	Medicaid	1817	443	24%	1.0	0.8	1.2	0.766
Median household income	Top 3 quartiles	3745	899	24%				
	Lowest quartile	2087	625	30%	1.6	1.4	1.8	<0.001
Hospital Location	Urban	342	69	20%				
	Rural	5602	1489	27%	1.6	1.4	1.8	0.002
Charlson comorbidity index	0–1	5595	1353	24%				
	2 and above	415	215	52%	1.4	1.1	1.8	0.007
Caustic ingestion type	Accidental	3043	660	21%				
	Suicidal	2949	908	32%	1.9	1.7	2.2	<0.001
Local complications	No	5316	1266	24%				
	Yes	676	303	45%	1.4	1.2	1.8	<0.001
Systemic complications	No	5471	1177	22%				
	Yes	540	392	73%	6.8	5.5	8.6	<0.001
Surgery	No	5942	1520	26%				
	Yes	69	49	71%	3.9	2.1	7.1	<0.001
Upper endoscope timing	<48 hours	5014	984	20%				
	= or >48 hours	997	585	59%	4.9	4.2	5.8	<0.001

Upper endoscope timing is in relation to admission time. Significant *p* value is less than 0.003.
Abbreviations: #, number of patients; LCI and UCI, the lower and upper limits of 95% confidence interval of the OR; OR, odds ratio; Pro LOS, prolonged length of stay, *p*, *p* value.

Table 4 Multivariate analysis of the factors associated with late endoscopy following caustic substance ingestion

		Total #	LaEn #	%	OR	LCI	UCI	*p*
Age (years)	0–18	1688	135	8%				
	18–40	2188	338	15%	2.4	1.9	3	<0.001
	40–65	1645	367	22%	3.4	2.7	4.4	<0.001
	>65	490	157	32%	4.2	2.9	6	<0.001
Gender	Female	2607	483	19%				
	Male	3404	514	15%	0.8	0.7	0.9	0.002
Race	Caucasian	2541	441	17%				
	AA	1409	226	16%	1	0.8	1.2	0.93
	Hispanic	804	155	19%	1.4	1.1	1.8	0.001
	Asian	155	21	13%	0.7	0.5	1.2	0.23
Geographic region	West	605	72	12%				
	South	2579	423	16%	1.4	1.1	1.9	0.01
	North East	1759	370	21%	1.9	1.4	2.5	<0.001
	Mid West	1068	132	12%	1.1	0.8	1.5	0.57
Hospital Teaching Status	Teaching	3803	547	14%				
	Nonteaching	2140	439	21%	1.3	1.1	1.5	0.002
Charlson comorbidity index	0–1	5577	859	15%				
	2 and above	415	138	33%	1.8	1.4	2.3	<0.001
Weekend admission	No	4330	667	15%				
	Yes	1682	330	20%	1.6	1.3	1.8	<0.001

Upper endoscopy timing is in relation to admission time. Significant *p* value is less than 0.003.
Abbreviations: #, number of patients; AA, African American; LaEn; late endoscopy, LCI and UCI, the lower and upper limits of 95% confidence interval of the OR; OR; odds ratio, *p*, *p* value.

which endoscopy should be avoided.[4,33] The premise of early endoscopic evaluation is to direct the management approach based on the extent of injury. Zargar *et al*. developed an endoscopic classification system assessing mucosal damage.[33] Patients with grade 1 or 2a injury can be started on oral intake in the first 24 to 48 hours.[21] Observation in the intensive care unit with nutritional support is indicated for grade 2b, 3a without the need for surgical intervention.[6,33,36] In those with grade 3b or full thickness necrosis, prompt surgical resection with primary reconstruction may reduce morbidity and mortality.[37,38]

Our results correlated the timing of endoscopic evaluation with the clinical and economical outcomes of CSI hospitalizations. Rapid classification of the patients might help sparing unnecessary costly treatments and hospital stay, on the other hand, it could prevent complications that might arise from

unrecognized necrosis by early surgical intervention. There was no significant difference in clinical outcomes between the endoscopies that were performed within 24 hours of admissions and those from 24 to 48 hours of admissions. However, patients who underwent an endoscopy after 48 hours had significantly worse morbidity and mortality.

With the increased economic incentives for hospitals to decrease the length of stay and cost of care, it is essential to maintain the high standards for providing care. This can be achieved by optimal utilization of available resources. Failure to adhere to expected quality measures also come with the added disincentive of payment reductions in many clinical conditions. Our results indicate for patients who underwent an upper endoscopy or EaEn following CSI, there was an association with statistically significant decreases in the cost and length of stay.

The strength of this study lies within the large number of patients included, since this study was based on nationwide data rather than data from a single center. Additionally, our findings expand the current knowledge of the epidemiology, timing of endoscopy, clinical and economic outcomes following CSI.

Our study is not without limitations. Germaine to any retrospective administrative database analysis, this study is susceptible to limitations inherent in a retrospective design, and to errors in data entry or inaccurate code assignation. These errors are expected to be random and most likely did not affect the direction as well as the degree of association observed in the analysis. Additionally, NIS data represent a time-limited cross sectional estimate of our outcomes that occurred within the same hospitalization for CSI, therefore we are not able to track the long-term complications following ingestion (i.e. esophageal strictures and cancer).

Another limitation of this study was the exclusion of patients who did not undergo endoscopy during the hospitalization for CSI (this comprises a majority of patients 63%). Based on our goal of determining the association of the time interval to endoscopy with outcomes following ingestion of a caustic substance, exclusion of patients who did not undergo endoscopy is logical and unavoidable. We believe that these patients could have been very ill (with signs of perforation) and were taken to the surgery without the need for upper endoscopic evaluation. Or their exposures were minimal and the decision was to observe them only. The nature of this billing-based database does not allow extraction of this information. Determining which patients admitted following CSI can be safely managed without endoscopy will require a prospective study design.

In this nationwide retrospective database analysis of patients who presented with CSI, undergoing LaEn was associated with higher prevalence of negative clinical and economic outcomes as compared to undergoing EaEn. More detailed observational or prospective studies are needed to further examine the reasons of delaying endoscopy and subsequent management pathways based on the endoscopic findings in order to overcome the limitations of this study. As early endoscopic evaluation could potentially improve the clinical outcomes and reduce costs of these admissions.

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APPENDIX I

Table: Univariate analysis of poor clinical outcomes

		Total #	Outcome #	%	OR	LCI	UCI	*p*
Age	<18	1688	112	7%				
	18–40	2188	213	10%	1.5	1.2	1.9	
	40–65	1645	307	19%	3.2	2.6	4.1	
	=>65	490	155	32%	6.5	5.0	8.6	<0.001
Gender	Female	2607	304	12%				
	Male	3404	484	14%	1.3	1.1	1.5	0.004
Race	Caucasian	2541	395	16%				
	AA	1409	158	11%	0.7	0.6	0.8	
	Hispanic	804	112	14%	0.9	0.7	1.1	
	Asian	155	31	20%	1.4	0.9	2.0	
	Others/Unknown	1103	92	8%	0.5	0.4	0.6	<0.001
Geographic region	West	605	54	8.9%				
	South	2579	436	16.9%	1.0	0.7	1.5	
	North East	1759	206	11.7%	2.2	1.7	2.7	
	Mid West	1068	92	8.6%	1.4	1.1	1.8	<0.001
Insurance	Private	1606	175	11%				
	Medicare	890	215	24%	2.6	2.1	3.2	
	Medicaid	1817	216	12%	1.1	0.9	1.4	
	Others	1699	182	11%	1.0	0.8	1.2	<0.001
Median household income	Top three quartiles	3745	450	12%				
	Lowest quartile	2087	294	14%	1.2	1.0	1.4	0.02304
Caustic ingestion type	Accidental	3137	670	12%				
	Suicidal	2875	117	28%	1.4	1.2	1.6	<0.001
Charlson comorbidity index	0–1	5595	670	12%				
	2 and above	416	117	28%	2.9	2.3	3.6	<0.001
Local complications	No	5335	598	11%				
	Yes	676	189	28%	3.1	2.5	3.7	<0.001
Surgery	No	5942	754	13%				
	Yes	69	34	49%	6.5	4.0	10.5	<0.001
Upper endoscopy timing	<24 hours	2593	278	11%				
	24–48 hours	2421	214	9%	0.8	0.7	1.0	
	= or >48 hours	997	296	30%	3.5	2.9	4.2	<0.001

Upper endoscopy timing is in relation to admission time.
Abbreviations: #, number of patients, AA, African American; LCI and UCI, the lower and upper limits of 95% confidence interval of the OR; OR, odds ratio, *p*, *p* value, significance threshold is 0.05.

APPENDIX II

Table: ICD9 codes used in the study

Identified variables	ICD9 diagnosis or procedure codes
Caustic ingestion	E86.10,1,2,3,4 E86.40,1,2,3,4 E98.06 E95.07 E95.87
Perforation	530.4 569.83 531.10,1 531.20,1 518.1 568.89 519.2 567.xx
Esophageal fistula	530.84
Acute liver necrosis	572.2 573.3 573.8
Hemolysis	283.xx
Aspiration pneumonia	507.0,1,8
GI bleeding	530.1x 530.2x 53082 531.xx 532.xx 533.xx 534.xx 535.xx 578.0 578.1, 569.3 578.9, 792.1
AKI	584.xx
DIC	286.6
Sepsis	038.xx 112.5 112.81 790.7 785.52 995.9x
Shock	785.5x
Intubation/mechanical vent	960.1,2,3,4,5 311 312.1,9 967.0,1,2
Parenteral nutrition	991.5
Upper GI endoscopy	422.3,4 423.3 434.1 441.3,4 444.3 434.9 451.3,4,6 453.0
Surgery (esophageal, gastric, intestinal, laparotomy, and thoracotomy)	424.0,1,2 425.1,2,3,4,5,6,8,9 426.1,2,3,4,5,6,8,9 435 436 437

Table: – *Continued*

Identified variables	ICD9 diagnosis or procedure codes
	438.1,9 439.1,9 468.1,2 541.1,2,9 542.1 340.2 342.1,2
Gastrostomy, G/J tube placement	431.1,9 432 970.2 963.6 463.2 443.2