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Diagnostic accuracy of drooling, reluctance, oropharynx, others, and leukocytosis score as a predictor of mortality and complications following acute corrosive ingestion

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Abstract:

OBJECTIVES: Esophagogastroduodenoscopy is considered the gold standard in assessing the severity of injury to the gastrointestinal tract following corrosive ingestion. Zargar's endoscopic grading of injury helps in prognostication as well as guiding management. Since the major burden of cases lies in resource-limited settings, the availability of endoscopic evaluation is a limiting factor. Hence, it is prudent to develop bedside tools that can be used as screening tools to identify patients at high risk of mortality and complications so that timely referrals and judicious utilization of resources can be made. Literature in this regard is limited and published studies have shown that clinical features fail to predict the severity of injury. We aimed our study to find the role of Drooling, Reluctance, Oropharynx, Others, and Leukocytosis (DROOL) score as a predictor of mortality and complications following acute corrosive ingestion.

METHODS: This was a diagnostic accuracy study conducted in the emergency department (ED) of a tertiary care hospital in North India. We screened all cases of acute corrosive ingestion presented to our ED. We collected the data on demographic profile, clinical features, investigations, endoscopy findings, treatment, and DROOL score. We followed patients for up to 12 weeks for outcomes including mortality and complications.

RESULTS: We studied 79 patients of acute corrosive ingestion. The median age was 26 years with a female predominance. Nausea, vomiting, and pain abdomen were the common symptoms. The median DROOL score was 4. The majority of our patients had normal to Zargar grade 1 injury to the stomach and esophagus. Out of 79 patients, 27 patients developed some complications. The overall mortality up to 12 weeks was 10%. The receiver operating characteristics (ROC) analysis was performed, and the area under the ROC (AUROC) curve of Zargar classification in predicting overall complications was 0.909 (96% confidence interval [CI]: 0.842–0.975) and it was 0.775 (95% CI: 0.553–1.000) in predicting mortality. The AUROC of DROOL score in predicting overall complications was 0.932 (95% CI: 0.877–0.987) and the AUROC of DROOL score in predicting mortality was 0.864 (95% CI: 0.758–0.970). The ROC analysis showed that a DROOL score ≤ 4 has a sensitivity of 96.2% and a specificity of 77.8% in predicting overall complications. Similarly, DROOL score ≤ 5 has a sensitivity of 81.7% and a specificity of 62.5% in predicting the development of mortality. Delong test showed that there was no statistically significant difference in Zargar versus DROOL score in terms of prediction of mortality and overall complications ($P > 0.05$).

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CONCLUSION: DROOL score is comparable to Zargar score in identifying patients at high risk of mortality and complications. Hence, DROOL score can be used for risk stratification of patients presenting with corrosive ingestion.

Keywords:

Complications, corrosive ingestion, drooling, reluctance, oropharynx, others and leukocytosis score, mortality, prognosis, sensitivity, specificity

Box-ED section

What is already known on the study topic?

- Corrosive or caustic ingestion is a common problem encountered in low- and middle-income countries
- Upper gastrointestinal endoscopy is considered as the gold standard in assessing the severity of injury to GI tract
- Clinical features fail to predict the severity of injury or prognosis following corrosive ingestion.

What is the conflict on the issue? Has it importance for readers?

- The use of a noninvasive clinical tool to predict severity of injury following corrosive ingestion is of utmost importance in resource-limited settings
- There is a paucity of literature on this aspect.

How is this study structured?

- This was a diagnostic accuracy study that includes data from 79 patients presented to emergency following corrosive ingestion.

What does this study tell us?

- DROOL score predicts mortality and complications following corrosive ingestion with a good sensitivity and specificity.

Introduction

Corrosive ingestion is a grave public health problem and a common medical emergency with high morbidity and mortality. It has devastating effects on the aerodigestive tract with the potential of causing certain immediate and long-term complications.[1,2] It is a major public health concern in both developed and developing countries but more common in the developing world. Apart from adding to the health-care costs, the long-term complications adversely affect the physical, psychological, and emotional well-being of the individual.

The most reported cases are among children where it is attributed to accidental exposure. In contrast, ingestion in adults is more often suicidal in intent and is frequently life-threatening. Commonly ingested corrosive substances are either alkalies or acids.[3] Other corrosives are oxidants, heavy metal salts, iodine tincture, paraquat, and some other chemical substances.[3] Acids cause coagulation necrosis and eschar formation that may limit substance penetration and depth of injury. Alkalies cause liquefaction necrosis and saponification and penetrate deeper into tissues. Extend of injury depends on the pH, concentration, amount, and nature of the ingested agent.

Esophagogastroduodenoscopy is considered the gold standard in safely assessing the extent and depth of injury. Zargar's endoscopic classification of mucosal injuries has been used in the management and prediction of complications post-corrosive ingestion.[4] Computed tomography and ultrasonography are gaining a more significant role in recent years, especially in addressing the need for emergency surgery.[5]

Several studies have shown that clinical features such as odynophagia, pain abdomen, and hematemesis are not very helpful in predicting the extent of injuries following corrosive ingestion. Studies on clinical scoring systems like DROOL [Table 1] (drooling of saliva, reluctance to eat, odynophagia, others, and leukocytosis) score for the purpose of predicting complications and mortality are limited.[6] With most cases being reported from resource limited low- to middle-income countries, it is imperative to study the role of such clinical tools in risk-stratifying patients to identify patients at higher risk of mortality and morbidity. It can help in identifying high-risk patients, timely referral, judicious use of resources, and early prognostication.

Drooling, Reluctance, Oropharynx, Others, and leukocytosis (DROOL) score is a noninvasive tool based on the clinical symptoms and signs of patients following corrosive ingestion. The total score ranges from 0 to 10, with 0 representing the worst score and 10 representing the best. We conducted this study with the primary objective of studying the role of DROOL score as a predictor of mortality and complication in patients of corrosive ingestion. Our secondary objectives were to study the clinical profile of patients presenting with corrosive ingestion and to identify the mortality and complications up to 12 weeks postcorrosive ingestion.

Methods

Study population, settings, and data collection

This was a diagnostic accuracy study conducted in the emergency department (ED) of a tertiary care teaching hospital in North India. We conducted this

Table 1: Drooling, Reluctance, Oropharynx, Others, and Leucocytosis score

Component of acronym	Signs and symptoms	Score of 0	Score of 1	Score of 2
Drooling	Drooling saliva	≥12 h	<12 h	No
Reluctance	Reluctance to eat or dysphagia or food intolerance	≥24 h	<24 h	No
Oropharynx	Oral and oropharyngeal burns	Severe lesions*	Edema/hyperemia	No
Others	Number of other signs/symptoms. Persistent fever, hematemesis, abdominal tenderness, retrosternal pain, dyspnea	≥2	1	No
Leukocytosis	High white blood cell count	≥20,000	<20,000	No

*Friability, hemorrhage, erosion, blisters, whitish membrane, exudates, ulcer or necrosis

study over a period of 18 months (October 2019 to April 2021). Ethical approval was obtained from the Institutional Ethics Committee for Post Graduate Research (IECPG-445/27.06.2019, RT-21/29.08.2019) before the commencement of the study. The estimated sample size for the study was 86 (proportion of complications-40%, power of the study −80%, α error −5%). We recruited a total of 79 patients for our study. We screened all the cases of acute corrosive ingestion presented to our ED irrespective of the age of the patient and agent involved. Those patients who were brought dead, who refused to give valid consent were excluded from the study. Patients with a history of mixed ingestions were also excluded from the study as a different management protocol would be necessary in such cases depending on the co-ingestant. Written informed consent was obtained from all the patients or legally accepted representatives. Data were collected in a predesigned pro forma, which included a demographic profile, chief complaints, findings of the general physical and systemic examination, relevant investigations, endoscopy findings, and treatment details. DROOL score was calculated in all cases. Patients were managed with proton-pump inhibitors, intravenous fluids, and antiemetics. Upper gastrointestinal (GI) endoscopy was performed by a team of gastroenterologists for all patients who were hemodynamically stable enough to be shifted to the endoscopy suite and esophageal and gastric injury was graded according to Zargar classification. Chest and abdominal X-rays were done to look for complications. The authors did not interfere in patient management. Patients were followed up at 12 weeks for outcomes including mortality and complications. Follow-up data were obtained from the hospital records and through telephonic interviews.

Statistical analysis

IBM SPSS statistical software (version 26.0. IBM Corp, Armonk, NY, USA) was used for the descriptive analysis. Data were presented as mean (standard deviation), median (interquartile range), and frequency/percentage as appropriate. 95% confidence interval (CI) for means and proportions were calculated. Statistical software Stata (version 16.1) was used for performing analytical tests and plotting Receiver Operating Characteristic (ROC) curve. ROC curve for mortality and overall complications at 12 weeks was plotted and area under ROC (AUROC) was calculated for diagnostic/screening tools. Delong test was performed to compare AUROC and $P \leq 0.05$ was considered statistically significant.

Results

A total of 79 patients who presented to our ED with a history of acute corrosive ingestion were included in our study. The median age of our study population was 26 years with a female predominance (55.7%). The nature of the agent ingested was found out from the container or a picture of the container produced by the patient or relatives. Acids accounted for most of the poisoning with a frequency of 92.4%. There was a single case of paraquat ingestion which was also included in our study. Most of the patients reached the hospital within 1 h following ingestion and ingestion in most cases was attributed to self-harm [Table 2].

Nausea, vomiting, and pain abdomen were the common symptoms with which patients presented to the ED. Hematemesis following corrosive ingestion was present in about 30% of cases [Table 2].

About 76 patients underwent upper GI endoscopy from the ED to stratify the severity of the injury. Endoscopy was not performed in the remaining three cases who were hemodynamically unstable to be shifted to the endoscopy suite. The median time to endoscopy was 20 h following admission in the emergency.

DROOL score was calculated for all patients and the median DROOL score in our study population was 4.

Zargar classification was used to grade the extent of injury to the esophagus and stomach post corrosive ingestion using upper GI endoscopy. Most of our patients had normal to grade 1 injuries to the stomach and esophagus, whereas grade 4 injuries to the stomach and esophagus were present in two cases each. The stomach was not visualized in three cases with Zargar 3B injury to the esophagus to prevent iatrogenic perforation. The details of endoscopic findings are provided in Table 3.

Table 2: Clinical profile of patients and complications

Parameter	*n*=79, *n* (%)
Age, median (IQR)	26 (20–34)
Gender	
Male	35 (44.3)
Female	44 (55.7)
Nature of agent	
Acid	73 (92.4)
Alkali	5 (6.3)
Other	1 (1.3)
Intention	
Accidental	36 (45.6)
Suicidal	43 (54.4)
Time to reach hospital (h)	
<1	43 (54.4)
>1	36 (45.6)
Symptom	
Nausea and vomiting	68 (86.1)
Pain abdomen	41 (51.9)
Odynophagia	36 (45.6)
Throat pain	32 (40.5)
Chest pain	27 (34.2)
Hematemesis	23 (29.1)
Drooling of saliva	14 (17.7)
Dysphagia	10 (12.7)
Hoarseness	9 (11.4)
Others	9 (11.4)
DROOL score, median (IQR)	7 (4–9)
Zargar score, median (IQR)	IIa (I–IIb)
Upper GI endoscopy performed	76 (96.2)
Time to endoscopy (h), median (IQR)	20 (14–28)
Complications	
Overall complications	36 (45.5)
Stricture	17 (21.5)
Upper airway injury	7 (8.9)
Acute kidney injury	5 (6.3)
Perforation	3 (3.8)
Aspiration pneumonia	3 (3.8)
ARDS	1 (1.3)
Mortality	8 (10.1)

IQR: Interquartile range, ARDS: Acute respiratory distress syndrome, DROOL: Drooling, Reluctance, Oropharynx, Others, and Leukocytosis

We followed up our patients till 12 weeks to study the incidence of complications and mortality [Table 2]. Out of 79 patients, 27 patients developed some complications. The immediate complications that we observed were airway injury (9%), acute kidney injury (6%), and GI tract perforation (3%). Esophageal stricture formation was the most common long-term complication observed (22%). The overall mortality up to 12 weeks was 10% with about 3% of cases dying within the first 7 days of ingestion [Table 2].

The ROC analysis was performed for data of 76 patients who underwent upper GI endoscopy and it showed that the AUROC of Zargar classification in predicting overall complications was 0.909 (96% CI: 0.842–0.975) [Figure 1]

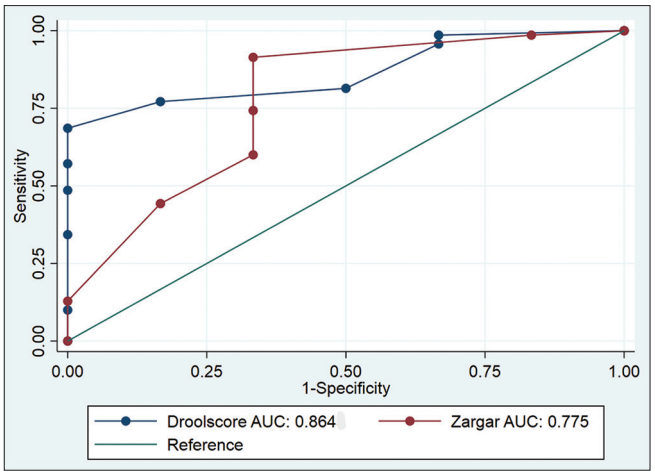

Figure 1: Receiver operating characteristics curve showing Zargar classification and DROOL score versus overall complications

and it was 0.775 (95% CI: 0.553–1.000) in predicting mortality [Figure 2]. The AUROC of DROOL score in predicting overall complications was 0.932 (95% CI: 0.877–0.987) [Figure 1] and the AUROC of DROOL score in predicting mortality was 0.864 (95% CI: 0.758–0.970) [Figure 2]. The ROC analysis showed that a DROOL score ≤4 has a sensitivity of 96.2% and a specificity of 77.8% in predicting overall complications. Similarly, DROOL score ≤4 has a sensitivity of 81.7% and a specificity of 62.5% in predicting the development of mortality [Table 4]. Delong test was performed to compare the AUROC of Zargar classification and DROOL score in predicting mortality and complications. The *P* value for AUROC of Zargar versus DROOL score in terms of mortality prediction was 0.51. The *P* value for AUROC of Zargar versus DROOL score in terms of overall complications was 0.52. Delong test showed that there was no statistically significant difference in Zargar versus DROOL score in terms of prediction of mortality and overall complications ($P > 0.05$).

Discussion

This was a diagnostic accuracy study involving 79 patients of acute corrosive ingestion presented to the emergency of a tertiary care hospital. The majority of our patients were young adults, with a median age of 26 years with a female predominance which was similar to other studies on corrosive ingestion.[7-10]

About 90% of our cases were attributed to acid ingestion which again goes in hand with a similar study conducted by Ananthakrishnan *et al*. in an Indian setting.[11] More than half of our cases had suicidal intent as the cause of corrosive ingestion, while the most common cause in the pediatric population was found to be accidental exposure. Similar results were observed in already published data.[4,8,12] Improper labeling of containers and

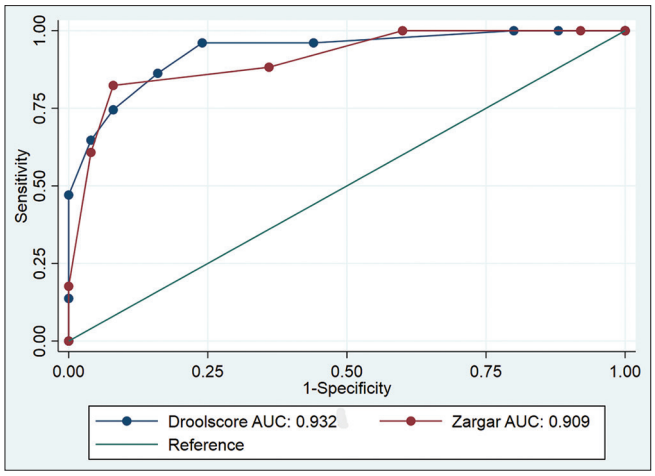

Figure 2: Receiver operating characteristics curve showing Zargar classification and DROOL score versus mortality

Table 3: Upper gastrointestinal endoscopy findings

Upper GI endoscopy finding	Esophagus (*n*=76), *n* (%)	Stomach (*n*=73), *n* (%)
Zargar class		
1	25 (32.9)	17 (23.3)
2A	17 (22.4)	9 (12.3)
2B	12 (15.8)	8 (11.0)
3A	7 (9.2)	7 (9.6)
3B	3 (3.9)	4 (5.5)
4	2 (2.6)	2 (2.7)
Normal	10 (13.2)	26 (35.6)

GI: Gastrointestinal

Table 4: Drooling, Reluctance, Oropharynx, Others, and Leukocytosis score (diagnostic test) performance

Score	Sensitivity (%)	Specificity (%)	NPV (%)	PPV (%)	LR+	LR–
DROOL score in predicting mortality						
2	98.5	25.0	90.0	10.0	1.31	0.05
4	81.7	62.5	96.8	19.5	2.17	0.29
6	69.0	100	96.6	100		0.30
DROOL score in predicting overall complications						
2	100	11.1	100	47.9	1.12	0.00
4	96.2	77.8	96.1	78.0	4.32	0.04
6	75.0	92.6	81.9	89.2	10.1	0.27

NPV: Negative predictive value, PPV: Positive predictive value, LR+: Positive likelihood ratio, LR–: Negative likelihood ratio, DROOL: Drooling, Reluctance, Oropharynx, Others, and Leukocytosis

keeping the containers within the reach of children might be the reasons for such accidental exposures in children. These are certain areas that need to be addressed when it comes to the prevention of corrosive exposure. Studies on corrosive exposures have also shown that these agents are easily available at home and are used for household purposes making them a commonly used agent for the purpose of self-harm.[13,14]

Upper GI endoscopy is considered the gold standard for assessing the extent and depth of mucosal injury following corrosive ingestion.[15-17] Zargar's classification is still used for endoscopic grading of the severity of mucosal injury and making treatment decisions. More than 90% of our patients underwent upper GI endoscopy within 24 h of ingestion and mucosal injury was graded by using Zargar's classification in these patients. The majority of our patients had either normal mucosa on endoscopic assessment or minor mucosal injuries (Zargar I) which is similar to the data reported by Faz *et al*.[18] Greater incidence of minor mucosal injuries may be attributed to the smaller quantities of agents consumed or may be due to the use of diluted compounds for household purposes.

Our follow-up data showed that the overall mortality following corrosive ingestion was about 10% and the overall incidence of complication development was 45%. Upper airway injury and acute kidney injury were the common immediate complications observed in our study. Esophageal stricture formation was the most common long-term complication observed which accounted for 22% of patients. Similar results were observed in studies conducted on complications following corrosive ingestion.[4,18,19] These long-term complications tend to have an adverse impact on the quality of life of patients who survive the acute event in terms of multiple hospital visits, the need for endoscopic or surgical interventions, and a high health-care expenditure.[20,21]

Zargar's classification of mucosal injuries has already been established as a useful tool in predicting the development of complications. It was studied that Zargar 3b injuries are associated with a higher incidence of stricture formation.[4] Zargar classification thus helps in risk stratifying patients, identifying patients requiring intensive care unit admissions and prolonged parenteral nutrition. The limited availability of upper GI endoscopy, especially in resource-limited settings, and the invasive nature of the investigation are the major drawbacks limiting the use of endoscopy in acute settings. The development of a less invasive, simple, bedside clinical tool for the purpose of risk stratification is thus necessary.

Studies have shown that clinical features and signs are always not very helpful in predicting the severity of injury. Studies on the use of clinical features such as pain abdomen, hematemesis, and odynophagia have shown that these features lack sensitivity and specificity in predicting the extent or severity of the injury. DROOL score as a clinical scoring system for predicting mortality and development of complications was studied in the past by Uygun *et al*.[6] and Mahmoud *et al*.[19] Studies on DROOL score in this regard are limited and the available data is on the pediatric population only.[6,19,22]

Our study showed that the AUROC of DROOL score in predicting mortality and development of complications were similar to those of Zargar's score for these purposes. Our ROC analysis showed that a DROOL score ≤4 has a sensitivity of 96.2% and specificity of 62.5% in predicting the development of complications. Similarly, a DROOL score ≤4 has a sensitivity of 81.7% and specificity of 62.5% in predicting mortality. Studies conducted by Uygun *et al*.[6] and Mahmoud *et al*.[19] showed similar findings. Uygun *et al*. in their study on the pediatric population showed that a DROOL score ≤4 had a sensitivity of 100% and specificity of 96% in predicting stricture formation. Another study conducted by Mahmoud *et al*. on the pediatric population showed that a DROOL score ≤5.5 had a sensitivity of 88% and specificity of 69% in predicting complications. Sharif *et al*., in their study on corrosive ingestion, showed that at a cutoff of <6.5, the DROOL score could predict esophageal injuries excellently, with AUC = 0.931; sensitivity, 91.7%; specificity, 72.5%; and overall accuracy, 91.3%.[22]

Although there is a paucity of literature on DROOL score, the available data favor the use of DROOL score as a risk stratification tool. Our study suggests that DROOL score is comparable to Zargar score in predicting complications and mortality following corrosive ingestion.

Limitations

This was a single-center, observational study with a limited follow-up period of 12 weeks. We recruited only 79 patients which is less when compared to the calculated sample size and similar studies published before. This happened because of a different protocol followed by our hospital in terms of investigating and managing cases of corrosive ingestions during the COVID pandemic compared to the pre-COVID period. A shorter follow-up period would have missed some long-term complications such as carcinoma formations. We did not study the psychosocial impact of these long-term complications in these patients. Follow-ups of most of the patients were carried out through telephonic interviews which would have led to underreporting of certain complications.

Conclusion

Corrosive ingestion is a major public health concern with immediate and long-term effects on the aerodigestive tract. DROOL score is comparable to Zargar classification in terms of prediction of mortality and complications and hence can be used for risk stratification, timely referral, and judicious use of available resources, especially in resource-limited settings.

Author contributions statement

JN and PA conceived the study. FP undertook recruitment of participants and data collection. SS and PA provided statistical advise and analysed the data. FPand SS drafted the manuscript and all authors contributed substantially to its revision. JN chaired the data oversight committee and takes responsibility for the paper as a whole.

Conflicts of interest

None Declared.

Ethical approval

Institute Ethics Committee for Post Graduate Research, All India Institute of Medical Sciences, New Delhi (IECPG-445/27.06.2019, RT-21/29.08.2019).

Consent to participate

Informed consent from the patient or next of kin depending on the age and clinical condition of the patient.

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