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ORIGINAL ARTICLE

Caustic ingestion in children treated at a tertiary centre in South Africa: can upper endoscopy be omitted in asymptomatic patients?

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Abstract

Purpose Considering that clinical presentation and gastrointestinal tract (GIT) injuries post-caustic ingestion vary in children, this study aims to establish whether a correlation exists between clinical presentation and endoscopic findings.

Methods This retrospective study comprised patients referred to a paediatric surgical unit between 2016 and 2018 within 72 h post-caustic ingestion. Data collected included caustic agents ingested, clinical presentation, endoscopic findings and management. Oesophageal injuries were graded according to the Zargar's endoscopic classification and gastric injuries classified as mild to severe.

Results Fifty patients with a mean age of 2.4 years were managed during the study period. Potassium permanganate (KMNO4) was the most frequently ingested substance in 27 (54%) patients. All 30 (60%) asymptomatic patients had no positive endoscopic findings regardless of clinical signs. Among the symptomatic patients ($n=20$), 15 (75%) had oesophageal injuries ($p=0.01$). Stridor was associated with a higher grade of oesophageal injury ($p=0.007$).

Conclusions Clinical signs and symptoms post-caustic ingestion correlated with endoscopic findings in our study. Endoscopy can be safely omitted in asymptomatic patients, including those with isolated staining secondary to KMNO4 ingestion. Symptomatic patients should have an endoscopy performed within 48–72 h of the insult to diagnose injuries.

Keywords Caustic ingestion · Oesophageal injury · Potassium permanganate · Endoscopy · Paediatric · South Africa

Introduction

The health burden posed by the ingestion of caustic substances is substantial with a global incidence of 5–518 events per 100 000. This burden is higher in developing compared with developed countries; the latter have witnessed a decline in cases due to security measures imposed on hazardous products. [1, 21].

In 20–40% of patients, ingestion of caustic substances result in a wide spectrum of gastrointestinal (GIT) injuries ranging from localised ulceration to perforation [1, 17]. The signs and symptoms suggestive of possible upper GIT injury are well described and generally easily recognisable. These include drooling, refusal to feed, dysphagia and odynophagia which may be present in up to 63% of patients with injuries [1, 17]. The majority (70%) of patients with isolated oropharyngeal burns do not have a significant oesophageal injury. Conversely, a small proportion (12%) of oesophageal injuries have no oral mucosal lesions. However, stridor and drooling are considered strong indicators of significant oesophageal injury [9]. Similarly, abdominal pain and haematemesis are features of gastric injury. Peritonitis, pleural effusion, sepsis and haemodynamic instability may be indicators of hollow viscus perforation. Exposure to acid substances can result in burns on the hands, chin, chest and other areas which may have come into contact with the corrosive substance [21]. This underscores that serious injury associated with the ingestion of caustic substances are unlikely to be asymptomatic.

Nevertheless, special investigations are regularly performed to confirm diagnoses, e.g. a diagnosis of upper GIT injuries is usually made on endoscopy. Considering that this is an invasive procedure, it is important to clearly

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identify the patients that require endoscopic investigation post-caustic ingestion. Although there are numerous studies that have attempted to establish if endoscopy is mandatory in all paediatric patients post-caustic ingestion, the results have been discordant [11, 26]. Some authors recommend that the decision for endoscopy should be based on the patient's presentation because patients with significant GIT injury present with suggestive signs and symptoms [11, 12, 5]. However, others state that symptoms are not reliable predictors of the presence or severity of injury [2, 6, 13, 22]. Therefore, the literature regarding the correlation between clinical signs and symptoms with endoscopic findings is inconclusive [11, 12, 16, 23, 26]. Further, there is a paucity of literature in developing countries, including South Africa, on this topic [21].

Establishing a correlation between clinical signs and symptoms post-caustic ingestion and GIT injuries may aid in identifying a select group of patients in whom endoscopy can be safely omitted in the local setting. This can potentially avoid a general anaesthetic procedure, related morbidity and mitigate cost in resource-constrained settings. This study, therefore, aims to (1) evaluate the management and outcomes of children post-caustic ingestion examined over a 2-year period at a tertiary South African healthcare facility and (2) determine whether endoscopy can be safely omitted in asymptomatic patients [16]

Materials and methods

Study sample and setting

The study population included all paediatric patients (0–12 years) with caustic ingestion managed by the Department of Paediatric Surgery, Inkosi Albert Luthuli Central Hospital (IALCH) over a 2-year period (01/06/2016 to 30/06/2018). Patients from the province of KwaZulu-Natal and certain areas of the Eastern Cape are referred to IALCH. The exclusion criteria were as follows: (1) more than 72 h post-caustic ingestion, (2) post-button battery ingestion and (3) unwitnessed caustic ingestion and with no convincing history or clinical suggestion of injury.

Data collection

A retrospective review and analysis of electronic patient medical records was performed. Data were captured by a clinician into an Excel spreadsheet. This included patient demographics, substance ingested, time to presentation, signs and symptoms on admission and management.

Classification of injuries on endoscopy

An upper endoscopy was performed up to the level of the second part of the duodenum in all patients if admitted within 72 h post-caustic ingestion. Oesophageal injuries noted on upper endoscopy were graded using the Zargar's endoscopic grading system (Table 1). Grade 1 to 2a injuries were classified as low-grade injuries and 2b to grade 3b injuries as high-grade injuries [1, 16]. Gastric injuries were classified as mild, moderate and severe based on extent and depth of injury which ranges from simple hyperaemia or erosions to diffuse transmural necrosis [9].

Management

Patients with no positive endoscopic findings and those with grade 1–2a oesophageal injuries were allowed to feed orally and were discharged home once oral feeds were tolerated. Those with grade 2b injuries were fed via a nasogastric tube (NGT). A patient with a grade 3a injury had a gastrostomy inserted for feeding. Distal feeding via an NGT or gastrostomy was continued for 7–14 days. Post-discharge, patients without injuries were followed up at the referral hospitals with a clear plan to contact our centre should any symptoms develop. All patients with positive endoscopic findings were followed up at our institution.

Statistical analyses

Statistical analyses were done using the statistical package for social sciences (SPSS) version 25. Continuous variables are presented as means while categorical variables are presented as counts and percentages. Categorical variables were analysed using the Chi-squared test. A p value < 0.05 was considered statistically significant.

Table 1 Zargar's grading classification of mucosal injury caused by ingestion of caustic substances [27]

Grade	Description
Grade 0	Normal mucosa
Grade 1	Oedema and hyperaemia of the mucosa
Grade 2a	Superficial localized ulcerations, friability and blisters
Grade 2b	Circumferential and deep ulceration
Grade 3a	Multiple and deep ulceration and focal areas of necrosis
Grade 3b	Extensive necrosis
Grade 4	Perforation

Ethical approval

The study was approved by IALCH, the Biomedical Research and Ethics Committee of the University of KwaZulu-Natal and the KwaZulu-Natal Department of Health (BE 483/19).

Results

Fifty patients were included in the study during the 2-year period comprising 35 boys (70%) and 15 girls (30%) with a mean age of 2.4 years (range 0.75–6 years). Mean time of presentation post-ingestion was 20.8 h (5–46 h).

Substances ingested

The majority of patients ingested alkalis ($n=42$; 84%) with about two-thirds ($n=27$) of these ingesting potassium permanganate (KMNO4). Other common alkalis ingested included caustic soda ($n=7$). One patient ingested an acid substance while in 7 patients the caustic agent ingested was unknown. (Fig. 1).

Clinical features at presentation

Of the 50 patients, the majority ($n=30$, 60%) were asymptomatic while 20 (40%) were symptomatic. Among the 30 patients who were asymptomatic, 22 had ingested KMNO4. Of these, 16 had isolated buccal mucosal staining following KMNO4 ingestion and six had staining of the hands or KMNO4 crystals under the fingernails. Among those that were asymptomatic, a single patient had a minor buccal mucosal burn (Fig. 2).

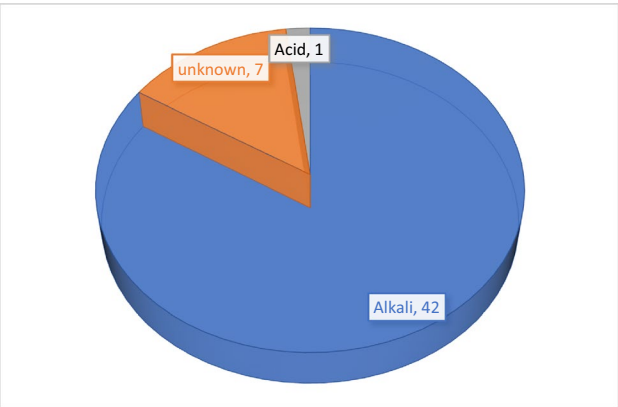

Fig. 1 Caustic substances ingested

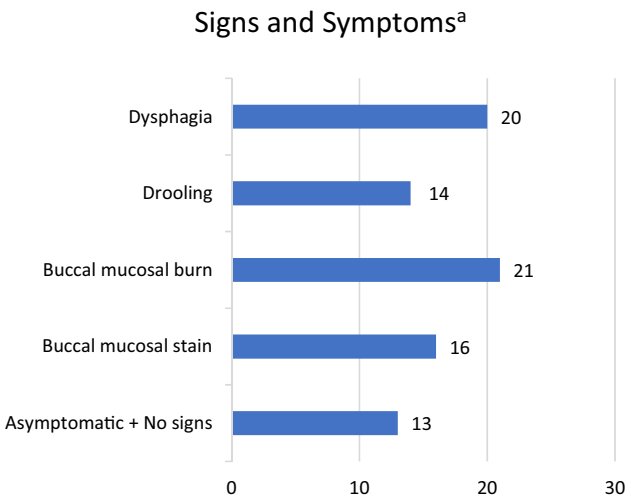

Fig. 2 Signs and symptoms at presentation

Among the 20 symptomatic patients, all had buccal mucosal burns on examination. Additionally, the 5 symptomatic patients who ingested KMNO4 had associated buccal mucosal staining (Fig. 3). Patients presented with one or more symptoms with key symptoms including isolated dysphagia ($n=6$) and stridor together with other symptoms ($n=3$). The majority of symptomatic patients ($n=14$) had a combination of dysphagia, odynophagia and drooling (Fig. 2).

Endoscopic findings

None of the 30 asymptomatic patients, regardless of clinical signs, had positive endoscopic findings. In contrast, the majority of the 20 patients with symptoms had GIT injuries ($n=15$, 75%) while five had negative endoscopic findings ($p=0.01$). (Table 2). Of the 15 patients with oesophageal injuries, 7 (47%) had associated pharyngeal burns. Notably, stridor, present in three patients, was associated with severe oesophageal injury ($p=0.007$). A further three patients with oesophageal injuries had associated gastric injuries which included the single patient who had ingested an acid substance. Of the 3 patients with gastric burns, one had ingested an unknown substance, and sustained a mild gastric burn involving the inferior aspect of the body of the stomach along the greater curvature. The other 2 patients, which included a single patient who had ingested acid and another who ingested an unknown substance, sustained mild burns involving the gastric antrum. All three of the patients with gastric injuries were symptomatic; 2 presented with epigastric pain, and the third with refusal to feed and drooling. (Fig. 3). There no cases of oesophageal or gastric perforation.

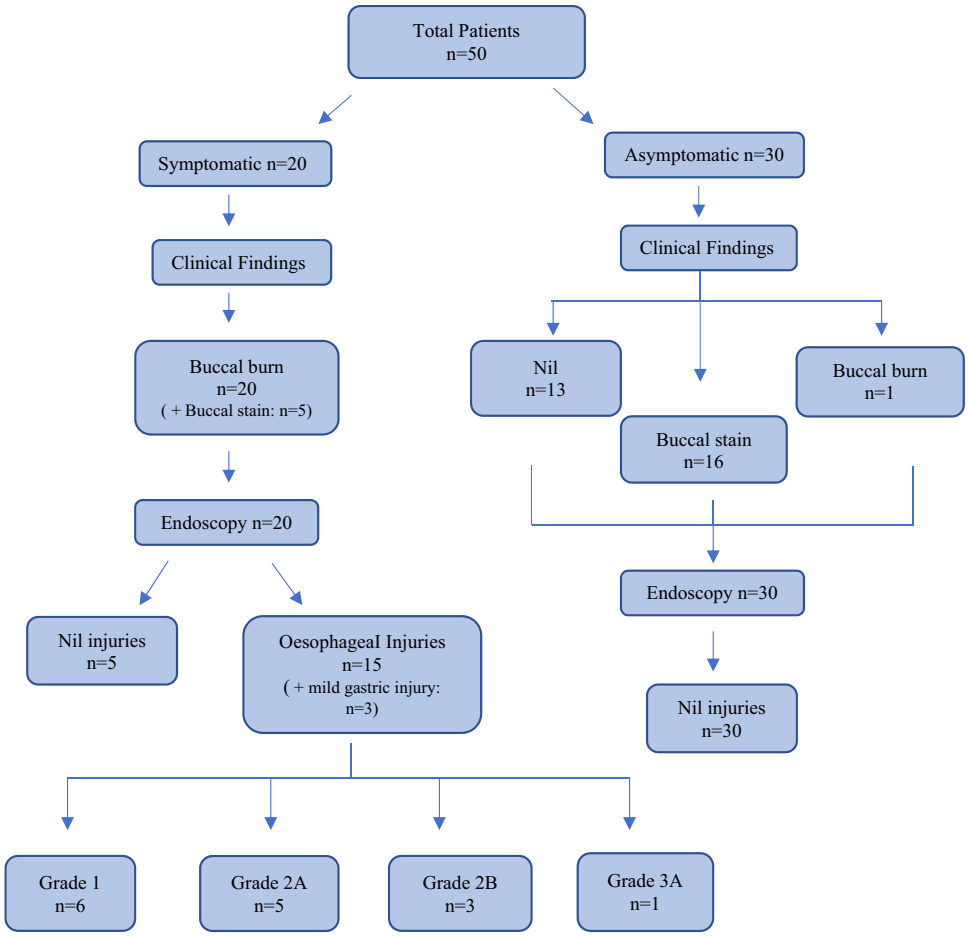

Fig. 3 Clinical presentation and endoscopic findings

Table 2 Correlation between caustic agent, clinical presentation and endoscopic findings

Endoscopic findings	Caustic agent			Clinical presentation[a]				
	Acid ($n=1$)	Alkali ($n=42$)	Unknown ($n=7$)	Buccal stain ($n=16$)	Buccal burn ($n=21$)	Dysphagia ($n=20$)	Drooling ($n=14$)	Stridor ($n=3$)
Oesophageal injury								
Grade 0	0	32	3	16	8	7	2	0
Grade 1	1	4	1	0	4	4	4	0
Grade 2a	0	4	1	0	5	5	4	0
Grade 2b	0	1	2	0	3	3	3	2
Grade 3a	0	1	0	0	1	1	1	1
Gastric injury[b]								
Mild	1	0	2	0	3	3	3	2
Moderate	0	0	0	0	0	0	0	0
Severe	0	0	0	0	0	0	0	0

[a]Patient may present with 1 or more symptoms

[b]All 3 patients with gastric injuries had oesophageal injuries

Substance vs grade of injury

Of the 42 patients with alkaline ingestion, 10 (24%) had oesophageal injuries (Table 2). Eight patients had low-grade injuries and 2 patients had high grade injuries. This included 4 patients post-KMNO4 ingestion (3 with grade 1 injuries and a single patient with a grade 2b injury). The single patient who ingested an acid had a grade 1 injury of

the oesophagus and a mild gastritis. Four of the 7 patients who ingested unidentified substances had varying degrees of oesophageal injuries and 2 had associated mild gastric injuries.

Management

Patients with stridor ($n=3$) were managed with a combination of nebulised adrenaline and intravenous steroids (dexamethasone). This medical management yielded a good response in one patient. However, 1 patient with grade 3 stridor and severe respiratory distress required intubation and admission into the intensive care unit for ventilation prior to endoscopy. The third patient was kept intubated following the endoscopy due to significant airway oedema. Buccal burns were managed with topical tetracaine oral gel and simple oral analgesia.

During endoscopy, 5 patients had no injuries and thus required no further management. Four patients with grade 1 oesophageal injuries required no intervention. Four patients post-KMNO4 ingestion, who sustained oesophageal injuries, had scattered crystals visualised in the oesophagus and stomach during endoscopy; these were irrigated and suctioned. Seven patients had a NGT inserted for postoperative feeding (3 with grade 2a oesophageal injuries and significant buccal mucosal burns, 3 with grade 2b injuries and 1 with a grade 3a injury). The NGT dislodged in the patient with a grade 3a injury and a gastrostomy was subsequently performed for feeding. The patients tolerated NGT and gastrostomy feeds well.

Outcomes

None of the asymptomatic patients or patient with negative endoscopic findings developed any symptoms requiring review.

At follow up, there was unfortunately no documentation regarding the outcomes of the buccal mucosal burns in any of the patients' records, but it is assumed they likely healed with no sequelae. All patients with grade 1 injuries and the 4 patients with grade 2a injuries were asymptomatic at follow up. No further investigations were conducted and they were discharged from our care. One patient with a grade 2a injury was lost to follow up.

Of the 3 patients with grade 2b oesophageal injuries, 1 patient was lost to follow up and the remaining 2 patients, on review, had dysphagia secondary to an oesophageal stricture confirmed on a water-soluble contrast study (this includes a patient post-KMNO4 ingestion). The patient with a grade 3a injury also developed an oesophageal stricture. There were no cases of antral or pyloric strictures. All oesophageal strictures were successfully managed with the oesophageal dilation programme utilized in our institution, which involved sequential dilation with Savary–Gilliard dilators.

Discussion

Our study showed a correlation between signs and symptoms post-caustic ingestion and the presence of GIT injuries. Asymptomatic patients and those without positive findings on clinical examination had no injuries on endoscopy. All patients with GIT injuries on endoscopy were symptomatic at presentation. These results are in keeping with a retrospective Danish study comprising 115 patients which found that asymptomatic children were unlikely to have any significant injuries and thus did not warrant endoscopy [8]. Similarly, in the United States a retrospective review of 28 patients as well as an Australian study which included 50 patients found that most patients with significant GIT injury had symptoms at initial evaluation and they suggested that endoscopy was not necessary in asymptomatic patients [11, 12].

The wide range of signs and symptoms found in our patients with GIT burns accord with those described in an Italian multicentre observational cohort of 162 paediatric patients. In keeping with our findings where stridor was associated with a higher grade of injury, the Italian study reported that major signs and symptoms such as dyspnoea, stridor and haematemesis were predictors of severe injury [5]. Similarly, a multicentre study of 285 children in the United States found that the incidence of significant GIT injuries without any signs and symptoms was very low and concluded that endoscopy could be avoided in asymptomatic patients [12].

In contrast, there are studies that have found that sign and symptoms could not accurately predict the presence and degree of GIT injury and they recommended endoscopy in all patients with a convincing history of caustic ingestion. A review article as well as a retrospective study of 156 children reported GIT injuries on endoscopy in the absence of buccal mucosal lesions or symptoms at presentation [9, 20]. Similarly, a Serbian retrospective study, with a cohort of 176 children which found that clinical signs could not be reliably used to exclude GIT injuries and they reported oesophageal injuries in up to 25% of their asymptomatic patients [6].

Despite the similarities in patient demographics, substances ingested and study design, the reasons for the differences between clinical presentations and endoscopic findings across studies remain unclear. It may be related to physical characteristics of agents, such as concentration, quantity ingested and interval between swallowing and referral to emergency department. However, this cannot be conclusively stated as this data was not included in some of the studies, and requires further investigation.

Similar to most studies, alkalis were the most frequently ingested corrosive substance in our patients [1, 10, 21]. The most frequently ingested alkalis are household cleaning agents and caustic soda (sodium hydroxide) [1, 11, 21, 26]. Contrary to this, more than half of our patients ingested KMNO4, which is an oxidising agent that leads to brownish staining and release of potassium hydroxide when in contact with moist mucosa, resulting in tissue injury [25]. In South Africa, this substance is available in powder or crystal form and often children mistake it for sherbert. The presentation and findings in patients with KMNO4 ingestion in our study was in keeping with the overall sample. Asymptomatic patients with isolated buccal mucosal staining had no injuries on endoscopy whilst most symptomatic patients (80%) had positive endoscopic findings. Although there is a paucity of literature pertaining to KMNO4 ingestion in children globally, the substance is frequently used in the local setting and consequently commonly associated with caustic ingestion in our paediatric population. KMNO4 is used locally as an antiseptic for cutaneous lesions and to decontaminate vegetables in agricultural practices. It is also believed to be an aphrodisiac regularly used in traditional medicine [24]. Nevertheless, another local study reported KMN04 ingestion in only 3 (7.5%) of 40 patients [18]. The patients in this study were comparable in age and sex to those in our study but it is possible, though not proven, that the lower prevalence of KMNO4 ingestion could be related to differences in geographical location and cultural practices perhaps influencing less access to this substance.

Alkaline compared to acid ingestion results in more severe oesophageal injuries [3, 10, 14, 17, 26]. The alkali agent causes liquefactive necrosis and with deeper penetration of tissue results in serious injury [3, 10, 16, 19]. This was demonstrated in two patients who sustained severe injuries in our study; another two patients had similarly severe injuries post-ingestion of unknown substances, which were likely alkalis.

Management and follow up of patients with oesophageal injuries is dependent on the grade of injury as was demonstrated in our study. Low-grade oesophageal injuries tended to heal with little or no sequelae in keeping with the literature [2, 7, 15, 16]. Patients with a higher grade of injury at presentation were more likely to develop complications as shown in our study where three-quarters of patients with a high-grade injury developed oesophageal strictures. Similarly, a Turkish study of 81 children reported an increasing incidence of stricture formation with increasing grade of injury [4].

In view of our study findings, and in keeping with the existing literature [5, 8, 11, 12, 22], we propose that management of patients post-caustic ingestion in our setting should follow a tailored stepwise approach based on the patient's clinical presentation (Fig. 3). This contrasts with our current management where the same approach and investigations are conducted in all patients post-caustic ingestion. Our tailored stepwise approach advocates differential management of patients who are symptomatic and asymptomatic post-caustic ingestion.

Despite all the required data being adequately detailed in patient records, the limiting factors in this study are the retrospective study design and the small sample size. The latter prevented unequivocal conclusions from being drawn (Fig. 4).

Conclusion

These study findings demonstrate that upper endoscopy can possibly be safely omitted in asymptomatic patients in our setting; there is likely to be a low risk of missing significant injuries. Patients with isolated buccal mucosal staining following KMNO4 ingestion can safely be observed as none were found to have any lesions on endoscopy. Symptomatic patients and those with clinical features suggestive of GIT injury should have an endoscopy performed within 24–72 h of ingestion and managed appropriately. Higher grades of injury have a propensity to develop oesophageal strictures and regular follow-up is advised. A prospective study with an adequately powered sample is required to conclusively assess if this approach can be safely adopted globally. Further, this study highlights the need to develop a programme to prevent the ingestion of caustic substances in children.

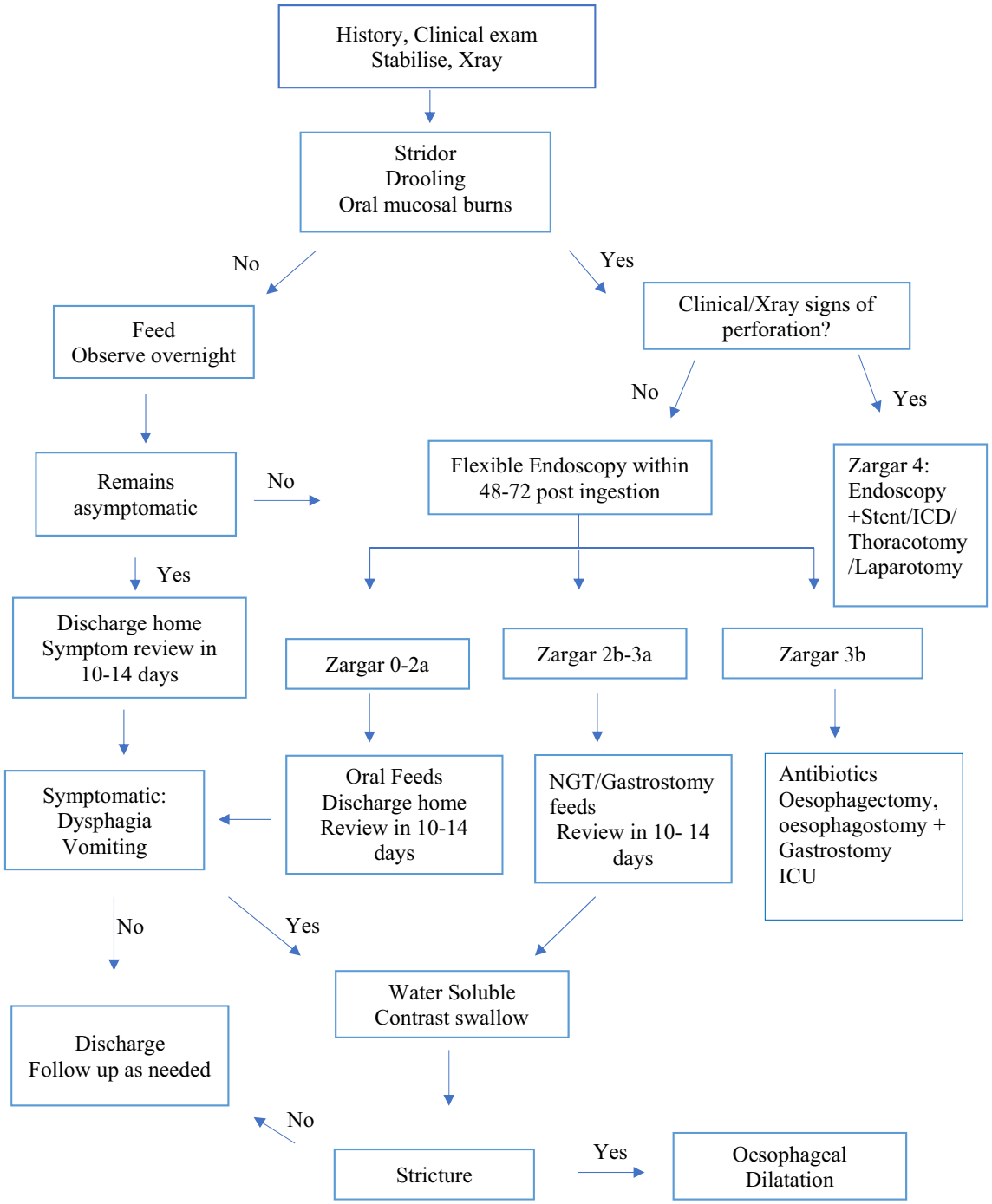

Fig. 4 Management algorithm for caustic ingestion (≤ 72 h post-ingestion)

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Declarations

Conflict of interest The authors declare that they have no conflict of interest.

Ethical approval The study was approved by IALCH, the Biomedical Research and Ethics Committee of the University of KwaZulu-Natal and the KwaZulu-Natal Department of Health (BE 483/19).

Informed consent For this type of study formal consent is not required.

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