Seminars in Pediatric Surgery 26 (2017) 95–104

Contents lists available at ScienceDirect

Seminars in Pediatric Surgery

journal homepage: www.elsevier.com/locate/sempedsurg

Caustic ingestion in children—A review

Marion Arnold, MBChB (Pret), DCH (CMSA), MMed (PaedSurg) (SU), FCPaedSurg (CMSA), Alp Numanoglu, MBChB, FCS (SA)*

Division of Paediatric Surgery, University of Cape Town, Red Cross War Memorial Children's Hospital, Cape Town, South Africa

ARTICLE INFO

Keywords:
Caustic ingestion
Corrosive
Paediatric
Oesophageal stricture

ABSTRACT

Various domestic or industrial chemicals may cause significant upper aerodigestive tract burns. Preventive measures should be up-scaled, especially in the developing world, to reduce the epidemic of accidental victims, largely unsupervised preschool children. External signs do not predict degree of injury. Non-invasive diagnostic screening includes radio-nuclear imaging, but early oesophago-gastroduodenoscopy remains the standard to predict stricture formation from circumferential submucosal scarring. Serial dilation is the mainstay of oesophageal stricture therapy, with oesophageal replacement reserved for severe refractory strictures. Intra-lesional steroid or mitomycin C may decrease the dilatations required for severe strictures, although long-term effects are unknown. Risk of secondary oesophageal carcinoma mandates long-term surveillance.

Introduction

Preventive measures have made significant impact on reducing caustic injuries in many countries. It is, however, still a goal that needs to be realised by many developing countries. Most caustic injuries are seen in countries where prevention is still lacking due to social, economic and educational variables. Half to 80% of the injuries are seen in children.[1,2] These are typically accidental in nature. This is in contrast to ingestion by adults which is often suicidal and frequently life-threatening. True prevalence of caustic injuries in children is not known but limited data available supports the large scale of the problem, which is a major public health issue.

The aim of this article is to discuss impact of caustic injuries and its sequelae, particularly in low and middle income countries (LMIC), to describe well-established treatment modalities and to look into the controversial management options.

Epidemiology

Ingestion of highly alkali or acidic substances is a major cause of morbidity and mortality worldwide, especially in developing regions. Victims are largely unsupervised preschool children.[1,2] Most taste or drink household cleaning agents due to curiosity or while searching for food or drink. Toddlers are most at risk, averaging 3 years of age at ingestion.[3] Risk factors for caustic ingestion in children include male gender,[4–6] attention-deficit/hyperactivity disorder symptoms,[4] lower parental education status,[4,7] young maternal age,[8] lack of parental supervision[8] and rural abode.[9] Incidence is reported at 5–518 paediatric caustic ingestion events per 100,000 populations per year, although noting a steady decline in higher income countries.[10–12] The majority of ingestions occur in children younger than 5 years old, and are totally preventable. Toxic ingestion in cases older than 5 years old is suspect and ingestion in adolescents is usually intentional. Mortality is rare but morbidity is devastating and in some cases, life-long.

A total of 20–40% of patients ingesting caustic substances may incur oesophageal injury.[13,14] Accidental ingestion of substances with an alkali (pH $>$ 11.5) or acid (pH $<$ 2) may cause significant burns to the cheeks, mouth, oropharynx, oesophagus and stomach and rarely duodenum, as well as airway.[15] Oxidising agents and phenols are not strong acids or alkalis but can burn exposed skin and gastro-intestinal mucosa, and also potentially cause other toxic effects. Tables 1 and 2 list common caustic agents and their attributes.[5,16–21]

Causative substances vary from region to region. Novel domestic cleaning product packaging (e.g., spray bottles and capsules) can introduce new sources of risk.[12,22] Industrial agents rival domestic agents in frequency of ingestion outside Europe and North America.[3] Oxidising substances such as peroxides or chlorine bleaches are the most commonly ingested substances,[5,23] although they rarely cause long-term gastro-intestinal sequelae. Overall, 7–25% of ingested substances lead to serious long-term gastro-intestinal morbidity with stricture formation.[5,13] Deep

*Correspondence to: Division of Paediatric Surgery, Institute of Child Health (ICH), Red Cross War Memorial Children's Hospital, 6th Floor, Klipfontein Rd, Rondebosch, Cape Town 7701, South Africa.
E-mail address: alp.numanoglu@uct.ac.za (A. Numanoglu).

http://dx.doi.org/10.1053/j.sempedsurg.2017.02.002
1055-8586/

Table 1
Strong alkalis and acids commonly implicated in paediatric caustic ingestion injury. Grey highlights substances with high risk for trans-mucosal injury.

Type	Caustic agent	Chemical formula	pH (at 25°C at maximum molar concentration of H^+/ OH^-(N), unless otherwise stated)	Common names	Household use	Incidence of associated strictures (concentration dependent)
Strong alkalis	Sodium hydroxide	NaOH	12.9 (100 mM) up to 14 (N)	Lye, caustic soda	Industrial detergents; drainpipe and oven cleaners ("degreasers"); hair relaxers; alkaline disk cell ("button battery")	Caustic soda crystals (46% concentration): 75%; oven cleaners 5–15% concentration: ~10–30%
	Potassium hydroxide	KOH	12.9 (100 mM) up to 14 (N)	Potash; also called lye	As above, including "non-lye" hair relaxers	~11%
	Lithium hydroxide	LiOH	14		Non-lye hair relaxers	None reported
	Calcium hydroxide	$Ca(OH)_2$	12.46	Lime; whitewash	Industrial, food preparation, paint, depilators etc.	
	Trisodium phosphate	Na_3PO_4	11.9 (1% aqueous solution) to 12.12 (at 100 mM)	Sodium phosphate	Cleaning agents and detergents including automatic clothes washing machines and dishwasher detergents	
		NH_4OH(aq)	Domestic cleaning agents; pH 6.5–10; hair relaxants: pH > 10; burns ≥ 5% concentration; 10% (industrial) concentration: pH13	Ammonium water	Industrial; Household cleaning agents, thioglycolate/sulphite hair relaxers	Up to 50% with ammonium chloride solution
	Disodium carbonate	Na_2CO_3	11.4 (1% aqueous solution) to 11.7 (10% aqueous solutions)	Sodium carbonate, soda ash, and washing soda	Soaps and detergents	
Strong acids:	Acetic acid	$C_2H_4O_2$	2.88 (100 mM)	Vinegar	Culinary and household cleaning agent	None
	Citric acid	$C_6H_8O_7$	2.2 (0.1 N); 3.2 at 1 mM		Automatic dishwasher and household cleaning agent; culinary	None
	Phosphoric acid(5)	H_3PO_4	Domestic preparations > 2 Industrial solutions > 85% corrosive; pH at 100% is 1.08		Household and industrial cleaning agents; derusting agent and dental use	
	Hydrochloric acid	HCl	1.08 (100 mM)		Limescale dissolver, swimming pool acid	~2%