

## Esophageal burn injuries with alkali in children: A four-year comprehensive analysis study

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### Abstract

**Introduction :** The incidence of caustic ingestion injuries in developed countries has been decreasing, while it still remains a great concern in developing countries including Iran. In this study we focused on alkali esophageal injuries in children which occur frequently in southern Iran, due to both, unsafe products and unfamiliarity of families with the alkali consumption hazards.

**Materials and Methods:** In a cross-sectional study, sixty four children who were admitted due to alkali ingestion at Nemazee hospital, Shiraz, Iran during a 4 year period, were evaluated for hospital stay, hospital charges and number of admissions. Data were obtained from medical records and through a phone survey.

**Results:** All ingestions were unintentional. Children had a prolonged hospital stay (m=13.2 day) and needed multiple admissions (m=7.8 admission). The mean hospital charge was \$14,580.00 USD for each patient.

**Conclusion:** High incidence and complications of alkali ingestion in south of Iran suggests a need for prompt preventive actions to stop the production of highly concentrated alkali and educating families for proper use of these substances.

### Keywords

- Caustics
- Ingestion
- Children
- Prevention

## Introduction

Although there has been a significant decline in esophageal burn incidence in developed countries, there is still a high incidence rate of accidental burn in many developing countries.<sup>1,2</sup> The most common cause of caustic injuries in adults is suicidal attempt,<sup>3</sup> whereas, in children most of esophageal burns develop due to accidental caustic liquid ingestions.<sup>4</sup> This happens most commonly in children younger than 5 years old and peaks in children under 3 years old when they can reach object but are not aware of their harms.<sup>5</sup>

In comparison to acids, alkalis are more harmful due to liquefy active necrosis, which penetrate the thickness of esophageal wall much deeper. As mentioned in many studies majority of burns occur by means of alkali.<sup>3,6</sup> Corrosive injuries are the most common cause of benign esophageal stricture. About thirty-five percent of patients with grade 2 esophageal burns develop stricture.<sup>7</sup> In grade 3 injuries or higher the chance of stricture is more than 75%.<sup>8</sup> Burn areas are susceptible to super imposed infections which can be the cause of severe malnutrition in these children.<sup>1</sup> Subsequently, the chance of esophageal cancer is 1000 fold higher amongst patients with esophageal burn.<sup>9</sup>

Injuries greater than grade 2 need hospital admission and endoscopic evaluation, repeated dilatations may also be required. Furthermore the dilatation itself increases the chance of esophageal perforation which can cause fatality.<sup>9</sup> From the economic point of view, treatment of esophageal stricture is costly and the economic burden is higher in developing countries.<sup>10</sup> The mean charges for each patient in the USA were calculated to be approximately \$28,860 US dollars in one year.<sup>11</sup> The incidence rate of esophageal burn is higher in low income families.<sup>11</sup> Due to frequent long term complications, patients may need to be admitted several times during their treatment. Strict laws and emphasis on high quality standard packaging in developed countries has been the main cause in diminishing esophageal burn incidence rate.<sup>11</sup> Chevalier Jackson started a public campaign for labeling the caustic substances.<sup>1</sup> However, in developing countries not implementing standard packaging is still a major obstacle. As well, in low socioeconomic families, parents are not well-informed about the safe usage of household chemical products.<sup>8</sup>

This problem in Iran is mostly due to caustic substances being used as an air conditioning cleansing solution which is commonly used in the southern region of the country.<sup>2</sup> These substances

commonly come in crystal form. After being dissolved in water, it is kept in a container similar to drinking water jugs. Unfortunately, accidental ingestions of this highly concentrated colorless, odorless and tasteless alkali are very common amongst children. Shiraz University of Medical Sciences is the largest referral center for pediatric surgery in southern Iran. Considering the high burden of caustic ingestion, we evaluated medical records of patients admitted to Nemazee hospital affiliated to Shiraz University of Medical Sciences, due to alkali esophageal burn in 4 years. This study aimed to evaluate the economic burden of this injury in order to develop suggestions and preventive measures in the community.

## Materials and Methods

This is a retrospective cross-sectional study, conducted on patients who were admitted with the impression of alkaline ingestion to the pediatric surgery or gastroenterology wards at Nemazee hospital, affiliated to Shiraz University of Medical Science, from March 2007 to March 2011. Two hundred and eighty two cases with the key words of esophageal burn, esophageal stricture and esophageal dilatation were evaluated. Sixty four cases completed the inclusion criteria that were: alkali ingestion and esophageal stricture due to alkali ingestion. Type of ingested caustic substance was obtained from their files. Exclusion criteria were: non-alkali esophageal burns, esophageal atresia, and non-corrosive esophageal strictures. Information such as: gender, age, number and duration of admissions, surgical or endoscopic interventions and total hospital charges for each patient was recorded. Due to the inflation rate, we updated the value of money spent on hospital charges and fees by using the "index of goods and services in urban areas of Iran" that is published by the central bank of Islamic Republic of Iran,<sup>12</sup> and then total cost was converted to United States dollars. In addition to reviewing medical records, we conducted a phone survey from these 64 patients. Twenty-one responded and were available. We asked about the education level and occupation of parents, number of children in family, questions about the nature of corrosive agent, and rough estimation of the amount ingested (more than 20 cc or less than 20 cc). Simple statistical tables were used to illustrate the data. Data analysis was done using SPSS 16.

## Results

From the 64 patients, 35 were male and 29 patients female, 54% and 46%, respectively. The age range of the subjects was 11 months to 14 years old with

a mean age of 3.4 years old. The distribution of age at the time of injury is shown in **Table 1**. During the 4 years of the survey, the number of readmissions oscillated from 2 to 40 times due to complications of caustic ingestion with a mean of 7.8 readmissions. The mean of hospital stay was 13.2 days for each patient. Esphagoscopy was performed in all patients by a pediatric gastroenterologist. Fifty children had

at least one dilatation procedure and 12 patients had colonic or jejunal inter position. There were no cases of mortality. The total admission cost of these 64 patients during the 4 year period was about 1 million US dollar (\$983,127.00) with a mean of \$14,580.00 share for each patient. The number of admissions, inpatient days and hospital charges were highest in 2-5 year-old group **Table 1**.

**Table 1:** admission characteristics

Age group (years)	N	Inpatient days (mean)	Hospital charges (U.S dollars)	Number of admissions
<2	32	12.4	13975	8
2-5	19	20.1	21029	10.1
>5	13	4.9	6642	4.3
Mean	64	13.2	14580	7.8

In our phone survey, 21 out of 64 patients were available and completed the questionnaire. All children had accidental ingestion. Educational level of parents is depicted in **Table 2**. The number of children in the family ranged from 1 to 6 with an average of 2.7 children. Four patients were the only child in the family, 8 had one sibling, while 9 patients had 2 or more siblings. Eleven patients were the first child of the family, 5 had one older sibling. The rough estimate of caustic substance ingested volume was less than 20 cc in 6 children

(28%), while 15 children (72%) ingested more than 20 cc. The most common ingested substance was conditioning units cleaner (n=12, 57%) followed by drain and pipe cleaner (n=3, 14%), dishwasher and utensil cleaners (n=4, 19%), and oven and stove cleaners (n=2, 9%).

Only four male parents had tertiary level education. On the other hand, 71% of the mothers of the 15 interviewed patients, were either illiterate or had primary education **Table 2**.

**Table 2:** Parents characteristics

Education level	Father		Mother	
	N	(%)	N	(%)
Illiterate	2	(9.5)	6	(28.5)
Primary	8	(38.0)	9	(42.8)
Secondary	7	(33.3)	6	(28.5)
University	4	(19.0)	0	(0.0)
Median age	35 (26-45)		33 (22-40)	

## Discussion

This study evaluated the high hospitalization cost of accidental alkaline ingestion in a referral hospital of the southern Iran. To our knowledge this survey

reports the highest number of alkaline ingestion cases in the shortest period of time in comparison to other studies.<sup>2, 3, 7, 13, 14</sup>

Alkali ingestion is much more harmful than acid

ingestion injuries due to liquefy active necrosis.<sup>1</sup> Unfortunately, there was a higher incidence rate of alkali ingestion in comparison to acid in most of the reports.<sup>3, 6</sup> Furthermore the alkali sold in Iran and used for cleaning purposes is Na OH and usually comes in crystal form. When it is dissolved in water, it becomes a highly concentrated solution which is colorless, odorless and tasteless with high in PH<sup>2, 10</sup>. It has been shown that a substance with PH=11 or higher is more dangerous even in small amounts in comparison with lower PH substances.<sup>4</sup> The degree of injury is related to age, concentration, volume of the ingested substance and duration of contact.<sup>1, 3, 10, 13</sup>

All patients in our study ingested caustic substance by accident. Generally, most of the related studies have also confirmed the unintentional caustic ingestion by adolescents.<sup>10, 14, 15</sup> The rate of incidence was highest amongst children under 5 years old which was also confirmed in our study.<sup>5</sup> This is the most common age because children are able to walk and skillful to localize different substances, but are unable to distinguish between good and bad.<sup>1</sup> It is worth noting that in most of the epidemiologic studies including the present one, there was a male predominance ratio.<sup>6, 16</sup>

On the other hand, mean duration of admissions varied in different studies.<sup>3, 5, 17</sup> In Johnson et al. study, the mean hospital stay was about 4 days<sup>11</sup>, while this time in our survey was 13 days. In our study, the longer hospital stay could be due to ingestion of highly concentrated alkali solutions which causes a deeper and higher grade of injury. Rafeey et al. observed that alkali ingestion increased the mean duration of hospital stay when compared to other substances.<sup>6</sup> All in all, the highest duration of admission and readmission belonged to the 2-5 years old group.

The higher the grade of injury, the higher the rate of complications, increasing the number of further admissions and more invasive procedures. Esophageal stricture is one of the most common complications that occur frequently in esophageal injury grade 2 or higher. Strictures may develop as early as 2 weeks after ingestion and may require multiple dilatations by rigid esophagoscopy.<sup>2, 19</sup> Dilatation itself may increase the possibility of perforation which is potentially fatal.<sup>20</sup> Severe cases of stricture need esophagectomy and esophageal replacement. These patients are at increased risk of esophageal carcinoma and need annual screening endoscopy for any sign of dysplasia.<sup>8</sup> Conclusively, treatment of caustic injury is time and money

consuming due to its chronic nature. Furthermore, these chronic injuries and multi readmissions increase the rate of missing school, disorderly behaviors by children and family feuds, also resulting in a high psychosocial burden.<sup>13</sup>

Economic burdens were evaluated in our study which was unexpectedly high for patients who were mostly from low socioeconomic level. Although there is a decline in caustic ingestion in industrialized countries, in 2012 Johnson reported that the annual burden for esophageal burn was about \$22,900,000.00 in the United States of America. The mean charge per patient was \$28,860.00.<sup>11</sup> In an Indian review article published in 2013, it was concluded that the burden of esophageal burn is relatively higher in developing countries compared to developed countries.<sup>10</sup> Furthermore, it was shown that the incidence rate of esophageal burns was higher in low and medium income families.<sup>11</sup> Similarly, in this study the majority of parents especially mothers had low level education. The low socioeconomic state of these families could be the reason for lack of knowledge about keeping and proper usage of chemical substances.<sup>14</sup>

As previously stated there is a decline in incidence of accidental esophageal burn injuries in developed countries.<sup>21</sup> However it is still considered as a major health threat in developing countries.<sup>14</sup> In general, overlooking standards, lack of sub clause in related acts leading to production of unsafe products, as well as lack of education and training of families will cause unsafe use of products with high concentrations. At the same time the use of non-original containers for household products is an additional issue. Awareness about the nature of caustic ingestion helps health policy makers to implement laws that will stop these frequent injuries in the future.<sup>10</sup>

### Conclusion

This study showed the high burden of esophageal burns, a preventable injury. Complications are crippling and create a huge psychosocial and economic chaos on families. A need for a prompt action is necessary to stop this problem. At this point we would like to make some suggestions for reducing the rate of accidental ingestions:

- 1) Educate families for proper storage of chemical substances and inform them about the complications of caustic substance ingestion.
- 2) Implement legislative actions in order to prevent the use of unsafe containers and put restrictions for commercialization of highly concentrated acids and alkalis available in the market.

3) Stop the production of crystal, odorless, tasteless alkalis, and instead start to produce colored, low concentrated liquids in child proof containers.

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