Clinico-demographic profile and outcome of acute pediatric hydrocarbon poisoning in South India

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ABSTRACT

INTRODUCTION Acute hydrocarbon poisoning in children is an important cause of morbidity and mortality in developing countries. This study aimed to understand the clinical-demographic profile and outcome of acute hydrocarbon poisoning in children belonging to low-middle economy families from South India.

METHODS A prospective observational study was conducted from January 2022 to June 2023 in a private medical college from South India for children between 1 month and 18 years of age admitted with a history of acute hydrocarbon poisoning.

RESULTS Out of 1568 admissions, 29 children had acute hydrocarbon poisoning. Median age was 2.6 years (range: 0.5–15 years). The majority (58.6%) belonged to the toddler age group. The male-to-female ratio was 1.6:1. Most (48.3%) cases were seen during summer. All poisonings were accidental and occurred via the ingestion route. Paint thinner (75.9%) and mosquito repellent (20.7%) were the most common agents implicated. Vomiting (69%), cough (24.1%), and respiratory distress (20.7%) were the predominant symptoms noted. Chest radiograph was abnormal in 10% of patients. Respiratory support was provided in 44% of patients; 70% of patients were discharged within 24 hours. There was no mortality.

CONCLUSIONS Acute hydrocarbon poisoning is a preventable cause of mortality and morbidity in children. The majority of cases occur in the toddler age group and are accidental. Most patients improve with simple conservative measures.

INTRODUCTION

Poisoning remains the fourth leading cause of injuries after road traffic accidents, burns, and drowning[1]. There is a considerable mortality risk with unintentional poisoning, and most such cases hail from low-middle-income countries[2]. Pediatric poisoning remains a common and preventable cause of morbidity and mortality worldwide[3]. Hydrocarbons (HCs) account for 5% of all pediatric poisoning admissions[4] and 90% of HC-related deaths involved children less than 5 years of age[4]. Hydrocarbons are a component of most household chemicals such as cleansing and disinfectant solutions, cooking fuel, insect repellents, etc., which are invariably found in all residences, making them a readily available potential toxic substance. The storage of such products in inappropriate containers, such as soft drink bottles and water storage cans, makes them easily accessible, especially for young, curious children who like mouthing things, resulting in unintentional HC poisoning.

The severity of HC poisoning depends upon the type, viscosity, volatility, and surface tension of the HC Compound[4].

Manifestations are primarily pulmonary, and the risk of aspiration is directly associated with viscosity[4]. Pulmonary complications include atelectasis, pneumonitis, pneumothorax, and pneumatoceles[4]. Cardiotoxicity manifests as dysrhythmias, secondary to HC sensitization of the myocardium to the circulating catecholamines[4]. Gastrointestinal manifestations like throat and abdominal pain, nausea, and vomiting are due to irritant effects[4]. Neurological complications include euphoria, depression, lethargy, convulsions, and coma[4]. However, acute HC poisoning in children can have a variable clinical presentation and outcome depending on the nutritional status, pre-existing co-morbidities, socio-economic factors, cultural beliefs and practices, the healthcare system of the country, etc.

The present study was conducted at a Pediatric Intensive Care Unit (PICU) in a tertiary care center affiliated with a private medical college in South India, catering primarily an urban population belonging to low middle-income socio-economic class. This study was performed to understand the clinical-demographic profiles and assess the radiological findings and outcome of acute HC poisoning in children.

METHODS

Study design and population

A prospective observational study was conducted over 18 months from January 2022 to June 2023, after obtaining institutional review board approval for ethical clearance with reference number IEC-DCMS-2024/60/009. All children between the ages of 1 month and 18 years with a history of acute HC poisoning admitted to pediatric intensive care unit (PICU) were considered for the study. Exclusion criteria included those children whose parents did not consent to participate in the study. The study was conducted in a South Indian private medical college that mostly serves working-class and lower-middle-class households. The institute follows the principles of early diagnosis, minimal hospital stay, and standard management protocols for every clinical diagnosis.

Measures and variables

A standard proforma was prepared and patient admission details were extracted. The proforma contained details about demographics, including age, gender, nature, amount of poison ingested, and residency. Details of clinical presentation [symptoms, signs, time of onset of symptoms/signs, time of presentation to the emergency room (ER)] were recorded in the proforma. Laboratory investigations (complete blood counts, chest X-ray), treatment (supportive care, antibiotics, oxygen, invasive or non-invasive respiratory support), and outcomes (discharge, death) were followed.

All children with acute hydrocarbon poisoning were scored for severity using the Gupta et al.[5] scoring system on admission. The predictive value of this scoring system is about 85%. The score ranges from 0 to 10 based on the 4 symptoms of fever, severe malnutrition, respiratory distress, and neurological symptoms. A score <4 indicates significant risk and warrants immediate hospitalization, 4–7 indicates a high risk of complications but likely to survive, and ≥8 predicts several-fold risk of death[5].

An assessment and management protocol for acute pediatric HC poisoning was followed. This included the admission criteria, clinical assessment, indications of respiratory support, panel of investigations, and treatment guidelines inclusive of fluid and electrolyte management, respiratory support, antibiotic use, supportive therapy, and weaning. No specific antidote is available for HC ingestion. Gut decontamination is contraindicated but topical decontamination was done. Resuscitation as per patient needs was provided. A chest X-ray was taken at admission if the child presented with respiratory distress to the hospital and a chest X-ray was performed 6 hours post-exposure in those patients who did not have respiratory symptoms on admission. Antibiotic therapy was initiated only for those with suspicion of superadded bacterial pneumonia.

Statistical analysis

Descriptive statistics, such as the mean and standard deviation, were used to present the data. The chi-square test was used to assess the independence or association between categorical variables, and the significance level in this study was set at $p<0.05$. The statistical analysis was carried out using Microsoft Excel Version 2405.

RESULTS

A total of 29 children with hydrocarbon poisoning were admitted during the 18-month study period, out of 1568 admissions. Of the 29 children, 18 (62%) were males and 11 (38%) were females. Although males outnumbered females, there was no statistically significant association between gender and hydrocarbon poisoning ($p=0.19$). The average age of presentation was 3.3 years and the median age of presentation was 2.6 years (range: 0.5–15 years). The majority of the children (n=17; 58.6%) were aged 2–5 years, followed by <2 years of age (n=8; 27.6%) and >5 years of age (n=4; 13.8%) and the association between age group and poisoning was statistically significant ($p=0.01$) (Table 1).

All cases belong to the urban population. Of the 29 patients, 18 (62%) were living in a joint family and 11 (38%) were in a nuclear family; however, the difference was not statistically significant ($p=0.19$). The reason for hydrocarbon poisoning in these children was not associated with the occupation of the parents in all cases, except one where the father was a goldsmith who worked with turpentine in the shed room in their house. The 15-year-old girl mistakenly consumed paint thinner, assuming it to be water at their relative's house. The common route of poisoning was ingestion and, in all cases, the poisoning was accidental. The most common poisons identified were paint thinner/turpentine (n=22; 75.9%) followed by all-out liquid (insect repellent) (n=6; 20.7%). Baygon (insecticide) poisoning occurred in only 1 (3.4%) case. The peak incidence of HC

Table 1. Demographic characteristics of the children admitted to the pediatric intensive care unit (PICU) with hydrocarbon poisoning, January 2022 to June 2023, South India (N=29)

Characteristics	n (%)	p
Age (years)		**0.01**
<2	8 (27.6)	
2–5	17 (58.6)	
>5	4 (13.8)	
Gender		0.18
Male	18 (62)	
Female	11 (38)	
Nature of hydrocarbon		
Turpentine	22 (75.9)	
All out (mosquito repellent)	6 (20.7)	
Baygon (insecticide)	1 (3.4)	
Season		0.18
Summer (March – June)	14 (48.3)	
Monsoon (July – October)	6 (20.7)	
Winter (November – February)	9 (31)	
Type of family		0.19
Joint	18 (62)	
Nuclear	11 (38)	

poisoning was noted during summer months accounting to 48.3% of total cases. However, the difference is not statistically significant (p=0.18) (Table 1).

All 29 children were symptomatic at the time of presentation. Vomiting (69%) and cough (24.1%) were the most common symptoms observed among the admitted cases. Respiratory distress was observed in 6 (20.7%) cases. Drowsiness was observed in 3 (10.3%) cases. Two (6.9%) cases presented with fever and abdominal pain each. None had seizure as a symptom either at the time of presentation or later during the hospital stay. The average time of presentation to ER was one hour thirty minutes with a range of 30 minutes to 2.5 hours, excluding 1 case which is the outlier who presented after 2 days of exposure. A chest X-ray was done on all 29 patients. Chest x-Ray was normal in 26 (89.7%) cases and evidence of pneumonitis in 2 (6.9%) patients, and pleural effusion was evident in 1 (3.4%) patient (Table 2).

The majority of the admissions required minimal supportive care. Respiratory support was required in 12 (44%) patients. Oxygen was needed for 9 (31%) patients and non-invasive ventilator support was needed in 2 (6.9%) patients. Intubation and invasive ventilation were needed in 1 (3.4%) case. Steroid was used in 1 (3.4%) patient who

Table 2. Clinical profile of the children admitted to pediatric intensive care unit (PICU) with hydrocarbon poisoning, January 2022 to June 2023, South India (N=29)

Variable	n (%)
Time of presentation to hospital post-exposure (hours)	
<3	26 (89.6)
3–6	2 (6.8)
>6 (presented at 48 hours)	1 (3.4)
Signs and symptoms	
Vomiting and nausea	20 (69.0)
Cough	7 (24.1)
Respiratory distress	6 (20.7)
Drowsiness	3 (10.3)
Abdominal pain	2 (6.9)
Fever	2 (6.9)
Loss of consciousness	1 (3.4)
Seizures	0 (0)
No symptoms	0 (0)
System involvement	
Gastro-intestinal	20 (69.0)
Respiratory	11 (38.0)
Neurological	4 (13.0)
Radiological features	
Pneumonitis	2 (6.9)
Pleural effusion	1 (3.4)
Normal	26 (89.7)
Treatment provided	
Oxygen	9 (31.0)
Non-invasive ventilation	2 (6.9)
Invasive mechanical ventilation	1 (3.4)
Steroids	1 (3.4)
Antibiotics	
None	25 (86.2)
Empirical and stopped	2 (6.9)
Empirical and continued	2 (6.9)
Hospital stay (hours)	
<24	20 (69.0)
24–48	4 (13.8)
48–72	2 (6.9)
>72	3 (10.3)
HPS score[a]	
<4	29
4–7	0
≥8	0
Outcome	
Survived	29
Died	0

[a] Hydrocarbon poisoning severity score[5].

presented with extensive consolidation and pleural effusion. Most (n=25; 86.2%) patients did not receive any antibiotics. Empirical antibiotics were started in 4 (13%) cases but were discontinued in 2 patients later (Table 2).

The mean duration of hospital stay was 33 hours (range: 4–150 hours). There was no mortality. Twenty (70%) patients were discharged within 24 hours, 6 (20%) were discharged between 24 to 72 hours, and only 3 (10%) patients required greater than 72 hours hospital stay. GI decontamination was not done in any case. Topical decontamination was performed in all patients as per the guidelines. All 29 cases had a hydrocarbon severity score of <4 on admission. All 29 cases were discharged home and were well at 28-day follow-up. There was no mortality.

DISCUSSION

Household chemicals are the most commonly reported cause of accidental poisoning in young children. In this study, hydrocarbon poisoning constituted 1.8% of the total 1568 admissions. HC poisoning occurred predominantly in the toddler age group. In our study, the overall incidence of hydrocarbon poisoning in children under 5 years of age was 86.2%. The results are consistent with a study conducted at Benha University, Egypt, by Madbolu et al.[6] where 76.4% of poisoning cases were seen in children less than 5 years age. In a study conducted in north India by Jayashree et al.[7], 94% children with HC poisoning were less than 5 years old and only 4 children were older than 5 years of age[7]. Young children are attracted to colorful packages and their immature olfactory function along with their explorative mouthing behavior makes them highly prone to accidental poisoning[8]. In Indian lower socioeconomic background households, kerosene, paint thinner and other daily-use hydrocarbon-based compounds are stored in water bottles or soft drink bottles and are sometimes inadvertently left in easily accessible areas which make young children prone to accidental poisoning.

Male preponderance was seen in this study with males constituting about two-thirds of total cases and similar results have been noted in various other studies as well[2,6,9]. The reason for this observation could be the higher degree of hyper-active character or inquisitiveness among boys[10,11].

The incidence of HC poisoning was highest during summer months compared to other seasons and this finding is common to most studies[2,7,11]. Excess thirst seen during the hot months prompt children to consume any liquids that are available within their reach mistaking them to be water or cold drinks. In this study, all cases of poisoning were accidental and this could be because almost most HC poisoning occurred in children less than 5 years of age. The 15-year-old girl mistakenly consumed paint thinner assuming it to be water at their relative's house.

In the present study, we observed that the incidence of paint thinner/turpentine poisoning was predominant involving three-fourths of HC poisoning in children and no cases of kerosene ingestion were observed. The primary reason could be explained by the place of study. This study was conducted in a hospital located in urban regions belonging predominantly to working and lower to middle socio-economic groups. Recent provisions of liquified petroleum gas (LPG) as cooking fuel to lower socio-economic groups at subsidized rates via a flagship scheme by the Indian government and ceasing provision of kerosene via ration have been attributed to fewer incidences of kerosene poisoning. Mosquito repellent and insecticide formed the remainder accounting for 21% and 3.5% cases of HC poisoning, respectively. We found that hydrocarbon poisoning seen in this cohort of children were not related to parental occupation, and hence cannot be perceived as an occupational hazard. In most cases, refurbishing of houses including painting and carpentry resulted in accidental poisoning as the leftover chemicals were stored in the houses and not discarded. This emphasizes the importance of raising community awareness.

The average time to presentation to the hospital emergency was one hour thirty minutes (range: half an hour to 3 hours 15 minutes) of exposure to HC poisoning, excluding 1 child who presented after 2 days of exposure. All cases belonged to urban areas and due to the prime location of the hospital, the average duration for presentation to ER is shorter in comparison to other studies[2,11]. All cases except one (28 out of 29) came to the hospital within 2.5 hours of ingestion.

All children had at least one symptom. Gastro-intestinal involvement mainly in the form of vomiting (69%) was the predominant symptom observed followed by respiratory (38%). Neurological involvement was noted in only 13% of children. A few studies showed a higher prevalence of respiratory symptoms followed by gastrointestinal and lastly neurological, but these studies were mainly from Middle Eastern countries[6,9,12]. Our study showed predominant gastrointestinal (vomiting) symptoms followed by respiratory and lastly neurological, which is similar to a study from eastern India[2]. This finding could be due to the cultural practice of inducing forced emesis in any patient with alleged poisoning in most parts of India and hence the definite etiology of vomiting occurring as a symptom of poison ingestion or as a treatment methodology based upon the cultural practice, cannot be distinguished. A few studies showed that vomiting after HC ingestion significantly correlated with pneumonitis[5,6,9]. We did not find any increase in the risk of pulmonary complications after vomiting, similar to the study by Dudin et al.[13].

Twelve (41.4%) patients required respiratory support in our study. In a study by Madboly et al.[6], 86.1% of patients were treated with supplemental oxygen for respiratory distress.

Antibiotic therapy was initiated in 4 patients for suspected secondary infection; however, this was continued in only 2 patients. The incidence of antibiotic use ranged from 31%

to 40% in most studies[2,6,9]. A South African study of 111 children aged below 5 years showed that secondary bacterial infection is rare (2 in 111) in paraffin poisoning, and all the patients recovered completely without antibiotics[13]. The low rates of antibiotic usage in our study could be due to strict adherence to protocols and most of our patients did not have severe illness as shown by the low hydrocarbon severity scores. This is supported by a review done by Das et al.[14] where it was found that there is no evidence for prophylactic steroids or antibiotics in pediatric acute HC poisoning, but may be warranted in the presence of pre-existing risk factors or pneumonitis and/or established secondary infections. Only one patient who presented after 2 days in severe respiratory distress due to consolidation and bilateral pleural effusion received steroids.

The low HC severity scores of all 29 patients in our study were accompanied by no deaths, which is consistent with previous research indicating extremely low death rates[6,9,14-17]. Most patients were discharged home within 24 hours of admission. As part of standard assessment and protocol including early resuscitation with minimal and as-required investigations and the policy of early discharge, the mean duration of stay was less than that in other studies[2]. The low HC severity scores of patients have also contributed to the shorter duration of stay.

Limitations

The limitations in our study include the inability to assess the amount of dose consumed and the relation between the dosage and severity/level of respiratory support, the possibility of response bias by parents who may not have completely reported the child's exposures and potential lack of generalizability to the larger population owing to the small sample size.

CONCLUSIONS

Acute hydrocarbon poisoning in children is a prevalent and preventable household hazard among the low and middle socio-economic classes in India. Majority of such poisonings are accidental in children and are most common in the toddler age group. Following unit protocols for the management of acute HC poisoning may avoid unnecessary investigations, unnecessary use of antibiotics/steroids, and promote early discharge.

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The authors have completed and submitted the ICMJE Form for Disclosure of Potential Conflicts of Interest and none was reported.

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DATA AVAILABILITY
Data sharing is not applicable to this article as no new data were created.

AUTHORS' CONTRIBUTIONS
ANM: conceptualized the study. SA and AA: designed the analysis. AA and VAK: conducted the study and collected the data. SA: performed the analysis. VAK: wrote the preliminary draft of the manuscript. SA: reviewed, edited and finalized the manuscript. RN and ANM supervised the study. All authors read and approved the final version of the manuscript.

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