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A Study on Assessment of Severity and Outcome in Children With Hydrocarbon Poisoning Using the Scoring System

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HIGHLIGHTS

1. Study evaluates severity of hydrocarbon poisoning.
2. Focus on children's poisoning outcomes.
3. Utilizes scoring system for assessment.
4. Aims to predict patient recovery potential.
5. Improves treatment strategies for poisoning cases.

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ABSTRACT

Hydrocarbon poisoning is a prevalent issue among children in developing countries like India, particularly in rural areas where these substances are commonly used for painting and lighting. Often stored in water or soft drink bottles, hydrocarbons attract children due to their appealing colors, and their low surface tension increases the risk of aspiration during ingestion, especially following vomiting, which can lead to chemical pneumonitis. This hospital based prospective observational study aimed to assess the severity and outcomes of hydrocarbon poisoning in children, focusing on their clinical profiles and associated complications. Utilizing a scoring system that evaluates six parameters cyanosis, SpO2 level, CNS manifestations, pulmonary involvement, respiratory distress, and history of vomiting the study measures illness severity in relation to hospitalization duration and complications like chemical pneumonitis or ICU treatment. A total of 48 children were evaluated, with 50% under three years old and 71% being boys. The majority of cases occurred during the summer months, with 77% of the children coming from rural areas. Notably, 73% of the children had a history of vomiting, with 69% of these cases being induced. Among those who vomited, 60% developed chest complications, while no complications were observed in children without vomiting. The average duration of hospitalization post ingestion was 24 hours, and 40% of the subjects experienced complications. Specifically, among those with complications, eight children had scores indicating mild severity (0 to 4), while six had moderate scores (5 to 8). This scoring system proves essential for evaluating the clinical severity and outcomes of hydrocarbon poisoning, emphasizing its prevalence among boys under three years and its occurrence during summer,with vomiting identified as a significant risk factor for chemical pneumonitis.

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INTRODUCTION

Poisoning in children is a significant health concern and ranks as the twelfth most common cause for admissions in pediatric wards. Hydrocarbon poisoning constitutes a notable fraction of total poisoning cases accounting for approximately 0.23% to 3.3%, with fatality rates ranging from 0.64% to 11.6%. Accidental poisoning is particularly prevalent among children under five years of age, and hydrocarbons are frequently the most common orally consumed poison in Indian children. The improper storage of substances such as paint thinner in drinking glasses, water bottles, and soft drink containers increases the risk of accidental ingestion, making these substances especially attractive to young children [1,2].

Hydrocarbons are a diverse group of organic compounds that contain carbon and hydrogen. Toxic exposure to hydrocarbons primarily affects the respiratory and central nervous systems. They can be found in various household products, including glues, nail polishes, paints, paint removers, pine oil, gasoline kerosene, furniture polishes, lamp oil, and lighter fluid. Often hydrocarbons are mixed with other agents, such as camphor aniline dyes, heavy metals and pesticides, which can introduce additional systemic toxicity [3,4].

The classification of hydrocarbons can be divided based on their chemical and clinical properties as well as their viscosity. Aliphatic hydrocarbons, for instance, are easily aspirated following ingestion and poorly absorbed from the gastrointestinal tract, leading to minimal systemic effects. Examples of aliphatic hydrocarbons include kerosene, mineral spirits gasoline, lubricating oil, naphtha, and mineral oils. Halogenated hydrocarbons such as trichloroethane and methylene bromide have different properties. They are less likely to be aspirated upon consumption and are readily absorbed by the gastrointestinal tract often resulting in systemic toxicity. Aromatic hydrocarbons, commonly used for inhalation, include toluene, benzene, and xylene [5,6].

When considering viscosity, hydrocarbons can be categorized into four groups. Very low viscosity hydrocarbons include mineral seal oil typically used in furniture polish. Low viscosity hydrocarbons encompass substances like benzene, aniline, pine oil, toluene, nitrobenzene, chlorinated hydrocarbons, camphor, and pesticides with hydrocarbon bases. Middle viscosity hydrocarbons include kerosene, gasoline, and lighter oil while high viscosity hydrocarbons are represented by lubricating greases, oils, petroleum jelly, motor oil and paraffin wax [7,8].

The toxicity associated with halogenated hydrocarbons, such as methylene chloride and solvent trichloroethane can lead to significant health problems. Chronic exposure can result in liver and renal toxicity while acute exposure may produce severe central nervous system effects. Moreover, solvents like xylene and toluene are often abused by inhalation methods referred to as achieve euphoric effects, which can also lead to serious health risks. For instance, cardiac arrhy thmias may occur due to the sensitization of the heart to catecholamines. Long term exposure to these subs tances can cause electrolyte imbalances, peripheral neu ropathies, and renal toxicity, further complicating the health risks associated with hydrocarbon exposure [9,10].

Chronic exposure to benzene is particularly concerning, as it is linked to the development of leukemia and aplastic anemia. Hydrocarbons are frequently used as solvents for highly toxic ingredients such as camphor, organophosphate insecticides, and heavy metals [11].

Paint thinners which commonly consist of a mixture of acetone benzene methanol naphthalene toluene, turpentine and xylene represent a significant source of hydrocarbon poisoning in children. The appeal of these substances is often heightened by their attractive colors and packaging, leading to increased risk for young children who are naturally curious and prone to exploring their environment [12].

The issue of hydrocarbon poisoning in children is a pressing concern, particularly in developing countries where these substances are prevalent in everyday household products. The lack of awareness among parents and caregivers regarding the dangers associated with improper storage and the potential for accidental ingestion is a critical factor contributing to this public health issue. With hydrocarbons being the most common poison consumed orally by children in India, it is imperative that parents, caregivers, and healthcare professionals are educated about the risks and preventive measures that can mitigate the incidence of poisoning. Awareness campaigns, proper storage solutions, and community education initiatives are essential steps in reducing the occurrence of hydrocarbon poisoning and ensuring the safety of children in their environments [13,14].

The primary objective of the study is to assess the severity and outcomes of hydrocarbon poisoning in children while the secondary objectives focus on examining the clinical profiles and complications associated with such poisoning in this age group.

MATERIALS AND METHODS

Study Design and Setting:

This prospective observational study was conducted at the Department of Paediatrics, at Bapuji Child Health Institute and Chigateri Government Hospital which are attached to J.J.M. Medical College, Davangere, from July 2022 to June 2024 for 2 years. Ethical approval has been obtained from the Ethical Approval Committee of Bapuji Child Health Institute, Davangere and Chigateri General Hospital.

Study Population:

The study population consisted of children under 18 years who presented with a documented history of hydrocarbon compound consumption. Children were excluded if they had organophosphorus poisoning, any chronic conditions such as renal failure, epilepsy, myocarditis, autoimmune diseases, or if they were pregnant. Additionally, those with an uncertain history of poisoning were not included in the study, ensuring a clear focus on confirmed cases of hydrocarbon exposure.

Data Analysis:

Data was entered and analyzed using SPSS (Statistical Package for Social Sciences) version 20. Descriptive statistics were calculated, including the mean and standard deviation for quantitative vari-ables based on the Shapiro Wilk normalcy test. Frequency and proportion were used for qualitative variables. Additional statistical tests were applied as necessary, depending on data distribution, to ensure appropriate analysis and interpretation of results.

RESULTS

In a study of 48 children, participants ranged in age from 1 to 6 years with a mean age of 2.5 years and a standard deviation of 1.25 years. Half of the children (50%) were aged between 2 and 3 years, while 25% were younger than 2 years and another 25% were older than 4 years. Of the participants, 71% were boys, and 29% were girls highlightinTable 1: Age V/s Sex distributiong a male predominance in the study group.

Table 1: Age V/s Sex Distribution

Age in years	Sex		Total
	Male	Female	
< 2	7 (20.59%)	5 (35.5%)	12
2 - 3	19 (55.88%)	5 (35.5%)	24
4 - 6	8 (23.53%)	4 (29)	12
Total	**34**	**14**	**48**

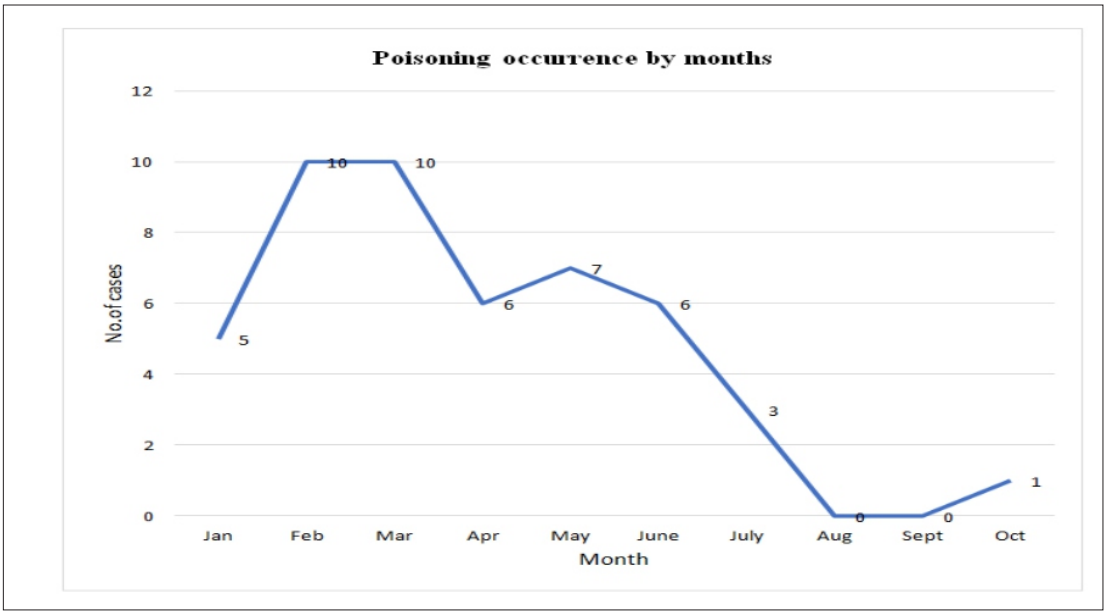

Figure 1: Poisoning Occurrence by Months

Conducted from January 2022 to June 2024 the study included 48 cases of hydrocarbon poisoning allowing for a monthly frequency assessment over the two-year period.

Table 2: Residence

Residence	Number of cases	Percentage
Urban	11	23%
Rural	37	77%
Total	**48**	**100%**

The children in the study were categorized based on their residence, with urban areas defined as those within corporation and municipality limits, while rural areas included those in panchayat and village regions. Out of the 48 subjects, 11 were from urban areas and 37 from rural areas, indicating a predominance of rural residents in the study population.

Vomiting:

Vomiting is a significant risk factor for chemical pneumonitis due to the increased likelihood of aspiration. In the study of 48 subjects, 35 (73%) experienced vomiting, with 24 (69%) of those cases induced by parents or caregivers and 11 (31%) occurring spontaneously. Among the 35 subjects who vomited, 23 developed complications related to chemical pneumonitis, while none of the subjects who did not vomit experienced any complications. This highlights the critical role of vomiting in the development of severe outcomes in cases of hydrocarbon poisoning.

Parents' education was categorized based on their highest level of schooling, with no parents being illiterate, graduates, or diploma holders. The majority of parents (46%) had completed high school, while 21% had attended primary and middle school, and 12% reached higher secondary school. This analysis aimed to explore the correlation between parental education and the incidence of induced vomiting in children, as higher educational levels are typically associated with fewer instances of induced vomiting, potentially reducing the risk of pulmonary complications. However, the data revealed that the distribution of children who experienced induced vomiting was consistent across the various education categories, indicating that parental education did not significantly impact the likelihood of inducing vomiting.

Table 3 : Relation between Number of Subjects and Induced Vomiting in Relation to Parents Education

Parent's Education	Number of cases (%)	Vomiting induced (%)
Primary school	21%	25%
Middle school	21%	21%
High school	46%	46%
Higher Secondary School	12%	8%

The analysis of the subjects based on the number of siblings revealed that 58% had one sibling, while 36% had two siblings. Additionally, 6% of the subjects had three siblings, with no subjects reported to have four or more siblings. This distribution indicates that most children in the study had either one or two siblings, highlighting a tendency towards smaller family sizes within this population.

Table 4 : Storage of Hydrocarbon Poisoning

Hydrocarbon poisoning	Number of cases	Percentage
Paint thinner	36	75%
Mosquito repellent (liquid vaporizer)	12	25%
Total	**48**	**100%**

All 48 cases of hydrocarbon poisoning occurred at home with 75% using paint thinner primarily for painting, while 25% utilized it as a mosquito repellent. Most subjects stored paint thinner in water bottles and it was often kept in easily accessible loca-tions, such as on the floor or in lower cupboard shelves, raising safety concerns regarding child access to these hazardous substances.

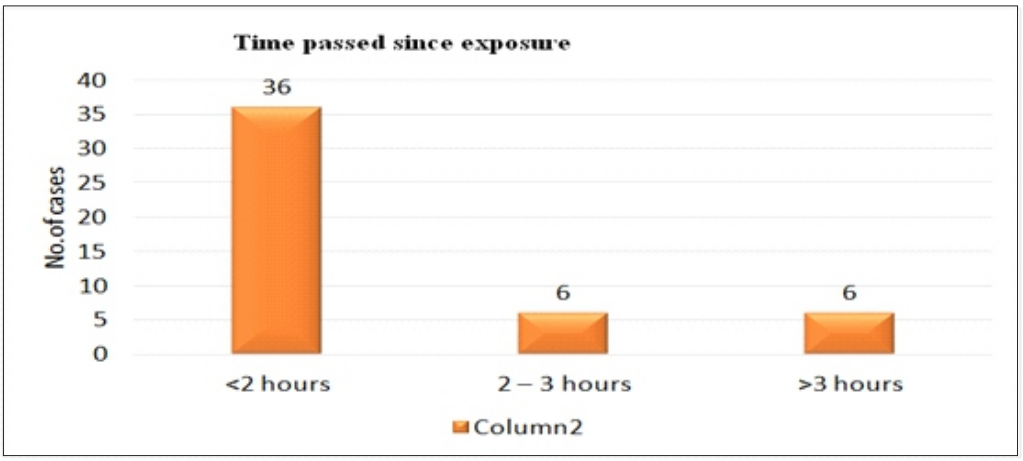

Figure 2: Time passed since exposure

Among the 48 subjects, 36 were admitted to the hospital within two hours of paint thinner ingestion, while six were admitted between two to three hours, and another six after three hours. The duration between exposure and hospitalization varied from half an hour to 13 hours, with a mean of two and a half hours and a standard deviation of two hours. Analysis revealed that those who presented earlier had a higher incidence of complications, particularly chemical pneumonitis, compared to those who arrived later for treatment.

Complications related to hydrocarbon ingestion were analyzed based on the time elapsed since exposure. Among the 48 subjects, 36 (75%) were admitted within two hours, with 11 of these (79%) developing complications. In the 2-3 hour group, which comprised six subjects (12.5%), only one (7%) experienced complications, while in the group exceeding three hours, two out of six subjects (14%) developed complications. Overall, 36 subjects (75%) experienced no complications, while 12 subjects (25%) developed chemical pneumonitis, highlighting a significant relationship between the timing of admi-ssion and the likelihood of complications.

A scoring system was utilized to assess hydrocarbon poisoning in subjects upon admission and every two hours for up to eight hours, with the highest score recorded for analysis. The scoring parameters included cyanosis, SpO2 levels consciousness, pulmonary involvement, respiratory distress, and history of vomiting, with a maximum score of 15. The scores were categorized as follows: 0 to 4 indicated excellent prognosis and no complications, 5 to 8 suggested complete recovery without complications, and 9 to 11 indicated the likelihood of developing chest complications such as chemical pneumonitis, and a longer hospital stay. Out of the 48 subjects, all showed no cyanosis, while 21 had SpO2 levels above 95%. Consciousness disturbances were observed in 18 subjects, and pulmonary symptoms were noted in 16 cases. Regarding respiratory distress, 22 subjects experienced only cough, while 35 had vomiting. Ultimately, 42 subjects achieved scores of 0-4, indicating excellent prognosis, while 6 subjects scored between 5-8, suggesting complete cure.

Table 5: Score Vs Complications

Score	Complications	Ventilator support	ICU admission
0 – 4	8	0	8
5 – 8	6	0	4

Among the subjects, 8 individuals who developed complications were categorized within the score range of 0 to 4, while 6 subjects with complications fell into the score range of 5 to 8. Additionally, 8 subj -ects with a score of 0 to 4 were admitted to the ICU for observation, along with 4 subjects from the score range of 5 to 8.

Table 6 : Total Cases Vs Cases with Complications in each Score Sategory

Score	Number of cases	Numbers of cases with complications
0 – 4	42	7
5 – 8	6	6

Table 7 : Outcome Distribution

Duration of inpatient treatment	Number of cases	Percentage
≤ 3 days	35	73%
4-7 days	13	27%

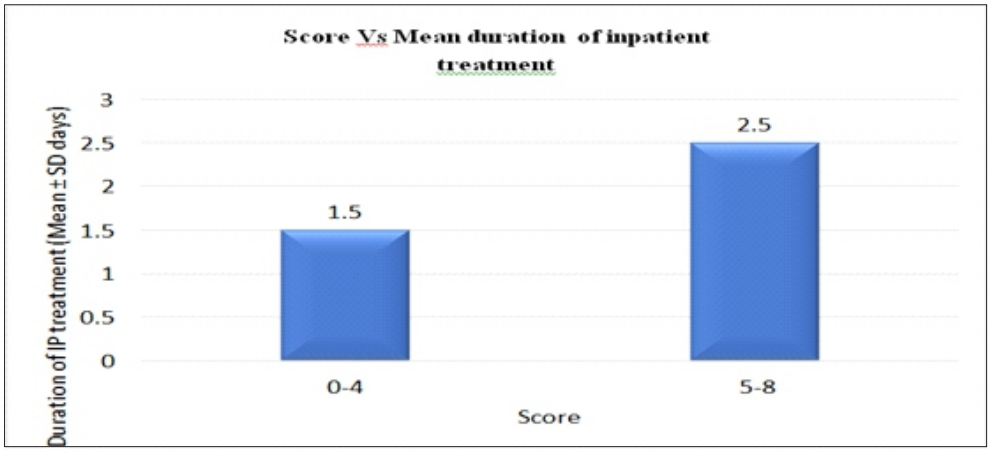

Figure 3: Score Vs Mean Duration of Inpatient Treatment

The duration of inpatient treatment varied by score category, with those scoring 0-4 averaging 1.5 days and those scoring 2-3 averaging 2.5 days.

DISCUSSION

Accidental poisoning in children particularly from hydrocarbons, is a significant issue in developing countries like India. In our study, paint thinner emerged as the leading cause of hydrocarbon poisoning, highlighting the need for stronger safety measures and public education. Most cases involved young children aged between 1 and 6 years, with the mean age being two and a half years. Eighty percent of the children were below three years, and this may be attributed to their immature olfactory function. The colorless or blue appearance of paint thinner, typically stored in water or soft drink bottles, makes it visually appealing to young children. In all cases, the hydrocarbon was stored in easily accessible places like the kitchen, and poisoning was most frequent in the summer months when children, feeling thirsty, mistook it for water or soft drinks due to the container used [15,16].

In terms of gender, 71% of the cases involved boys, and poisoning was most common in boys aged 2 to 3years. The higher prevalence in boys may be due to their more active and curious nature, leading to accidental ingestion of harmful substances. Most cases came from rural areas, accounting for 77% of admissions, as hydrocarbon usage is more widespread there, especially for cooking and painting. In contrast to other studies that found kerosene to be the most common

hydrocarbon ingested, our study identified thinner oil as the leading cause. This shift could be due to the increased use of LPG for cooking, reducing the reliance on kerosene [17].

Vomiting occurred in 73% of cases, with 69% being induced by parents or caregivers, while the rest were spontaneous. Vomiting increases the risk of aspiration and subsequent complications like chemical pneumonitis. Among those who vomited 60% developed complications, whereas no complications were observed in children who did not vomit. Interestingly, there was no correlation between parental education and induced vomiting. In most cases, caregivers, including grandparents, induced vomiting without understanding the risks [18,19].

Assessing the amount of hydrocarbon ingested proved challenging since parents and caregivers could not provide precise information. Regardless, complications are often linked to the amount of hydrocarbon aspirated rather than ingested. Most children were brought to the hospital within two and a half hours of exposure, with 75% arriving within two hours. Those who presented earlier had higher complication rates, possibly due to severe respiratory distress and central nervous system symptoms, which prompted immediate referral to a tertiary care center. Children with less severe symptoms were initially treated at nearby hospitals and referred later [20,21].

Of the total cases, 75% developed complications, with 12 children experiencing chemical pneumonitis. The scoring system for hydrocarbon poisoning, which was used to assess children every two hours up to eight hours, proved to be an effective tool for bedside evaluation. Respiratory symptoms were more common than CNS involvement, and the scoring system gave more weight to respiratory manifestations by including two separate parameters: pulmonary involvement (based on auscultation) and respiratory distress (measured by respiratory rate and accessory muscle use) [22,23].

The severity of complications correlated with the scores in categories 0 to 4 and 5 to 8. In the lower score category (0 to 4), eight children required ICU admission, while the mean duration of hospitalization for this group was two days. For the 5 to 8 score category, the mean duration of hospitalization extended to five days. This demonstrates the scoring system's effectiveness in predicting the severity of illness and clinical outcomes in hydrocarbon poisoning cases. In conclusion, hydrocarbon poisoning, especially from paint thinner, is a serious concern among young children in rural India, with vomiting being a major risk factor for developing complications like chemical pneumonitis. The scoring system is a valuable tool in managing such cases, aiding in the prediction of complications and hospitalization duration [24].

CONCLUSION

The hydrocarbon scoring system is a useful bed-side tool for assessing clinical severity and predicting outcomes in hydrocarbon poisoning cases. In our study, paint thinner was the most common source, with poisoning cases primarily occurring in boys under three years old, particularly in rural areas. Vomiting, especially induced vomiting, increases the risk of chemical pneumonitis due to aspiration. Parental education is crucial in preventing accidental poisoning, as most cases were stable with minimal complications.

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