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Correlation of Radiological Lung Involvement with Clinical Severity and Nutritional Status in Children with Kerosene Poisoning.

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Abstract

Background: Kerosene poisoning remains one of the most common accidental household poisonings among children in developing countries. Aspiration of kerosene frequently leads to pulmonary complications ranging from mild pneumonitis to severe respiratory distress. Radiological assessment using Foley's criteria may help in determining severity and prognosis. Nutritional status may further influence the clinical outcome in affected children. ***Aim:*** To study the correlation of radiological lung involvement with clinical severity and nutritional status in children with kerosene poisoning. ***Objectives:*** To assess radiological lung involvement using Foley's criteria. To evaluate the association between radiological lung involvement and clinical severity. To study the correlation between nutritional status and severity of radiological lung involvement. ***Materials and Methods***: This prospective observational study was conducted in the Department of Pediatrics of a tertiary care teaching hospital over a period of 18 months. A total of 110 children aged 6 months to 12 years with accidental kerosene poisoning were included. Detailed clinical history, examination findings, nutritional assessment, laboratory investigations, and chest radiographs were recorded. Radiological involvement was graded according to Foley's criteria. Statistical analysis was performed using Chi-square test and relevant inferential statistics, with $p<0.05$ considered significant. ***Results:*** The mean age of the children was 3.11±0.63 years. Radiological pneumonitis was present in 74 (67.3%) children. According to Foley's criteria, Grade I involvement was seen in 39 (35.5%) children, Grade II in 25 (22.7%), Grade III in 20 (18.2%), and Grade IV in 26 (23.6%) children. Symptomatic presentation was observed in 95 (86.4%) children. Severe acute malnutrition was present in 45 (40.9%) children and showed significant association with severe radiological involvement ($p=0.001$). Higher Foley grades were significantly associated with prolonged hospital stay and increased clinical severity ($p<0.001$). Mortality was observed in 2 (1.8%) children. ***Conclusion:*** Radiological lung involvement is strongly associated with clinical severity and nutritional status in children with kerosene poisoning. Higher Foley grades correlate with prolonged hospitalization and increased morbidity. Severe acute malnutrition significantly increases the risk of severe pulmonary involvement. Early radiological evaluation and nutritional assessment are essential for effective management and prognostication.

Keywords: Kerosene poisoning. Radiological pneumonitis. Foley's criteria.

INTRODUCTION

Poisoning remains one of the important causes of pediatric morbidity and mortality worldwide, particularly in developing countries where hazardous substances are easily accessible within households. Among various forms of childhood poisoning, kerosene poisoning continues to be a major public health concern in India due to the widespread domestic use of kerosene as a cooking and lighting fuel. Young children, especially toddlers, are naturally curious and tend to explore their surroundings by putting objects and liquids into their mouths, making them especially vulnerable to accidental ingestion of toxic substances. Improper storage of kerosene in soft drink bottles, water containers, steel glasses, or medicine bottles further increases the risk of accidental ingestion. Socioeconomic factors such as poverty, overcrowding, illiteracy, inadequate parental supervision, and unsafe storage practices contribute significantly to the occurrence of kerosene poisoning in children.[1]

Kerosene belongs to the hydrocarbon group of compounds derived from crude petroleum. The principal toxicity of kerosene is due to aspiration into the respiratory tract, resulting in chemical pneumonitis. The low viscosity, high volatility, and low

surface tension of kerosene facilitate rapid spread into the tracheobronchial tree and alveoli, leading to inflammation, edema, alveolar collapse, ventilation-perfusion mismatch, and hypoxia. Clinical manifestations commonly include cough, vomiting, fever, tachypnea, respiratory distress, chest retractions, cyanosis, and occasionally neurological symptoms such as irritability, drowsiness, convulsions, or coma. Radiological abnormalities may appear within a few hours after ingestion and commonly include parahilar infiltrates, basal infiltrates, bronchopneumonia, and extensive lung involvement.[2]

Radiological evaluation plays a crucial role in assessing pulmonary involvement in kerosene poisoning. Foley's criteria are commonly used to grade the extent of lung involvement on chest radiographs, and several studies have shown that greater radiological involvement correlates with prolonged hospitalization, severe respiratory symptoms, complications, and poor outcome. However, some children may remain asymptomatic despite significant radiological changes, emphasizing the importance of imaging in early diagnosis and prognostication. Nutritional status is another important determinant of outcome in pediatric poisoning. Malnourished children have reduced immunity, poor pulmonary reserve, delayed recovery, and higher susceptibility to severe respiratory complications following aspiration injury.[3]

Despite the persistent burden of kerosene poisoning in India, limited studies have specifically evaluated the correlation between radiological lung involvement, clinical severity, and nutritional status in affected children. Understanding this relationship may help clinicians identify high-risk patients early, predict outcomes, and initiate timely management strategies. Therefore, the present study was undertaken to evaluate the correlation of radiological lung involvement with clinical severity and nutritional status in children admitted with kerosene poisoning in a tertiary care hospital.[4]

AIM

To study the correlation of radiological lung involvement with clinical severity and nutritional status in children with kerosene poisoning.

OBJECTIVES

1. To assess the radiological lung involvement in children with kerosene poisoning using Foley's criteria.
2. To evaluate the association between radiological lung involvement and clinical severity in children with kerosene poisoning.
3. To study the correlation between nutritional status and severity of radiological lung involvement in children with kerosene poisoning.

MATERIALS AND METHODS

Source of Data

The data for the present study were collected from children admitted with kerosene poisoning to the Department of Pediatrics in a tertiary care teaching hospital. Clinical, demographic, radiological, and laboratory details of all eligible children were recorded in a predesigned proforma after obtaining informed consent from parents or guardians.

Study Design

The present study was a hospital-based prospective observational study.

Study Location

The study was conducted in the Department of Pediatrics of a tertiary care teaching hospital attached to a medical college.

Study Duration

The study was conducted over a period of 18 months from January 2024 to June 2025.

Sample Size

A total of 110 children with kerosene poisoning fulfilling the inclusion criteria were enrolled in the study.

Inclusion Criteria

1. Children aged 6 months to 12 years.
2. Children admitted with history of accidental kerosene ingestion.
3. Children whose parents or guardians provided informed consent for participation in the study.

Exclusion Criteria

1. Children with poisoning due to substances other than kerosene.
2. Children with pre-existing chronic respiratory disease.
3. Children with congenital heart disease or severe systemic illness.
4. Children with incomplete clinical or radiological records.

5. Children whose parents or guardians refused consent.

Procedure and Methodology

After admission, a detailed history was obtained from the parents or caregivers regarding age, sex, socioeconomic status, quantity of kerosene ingested, mode of ingestion, time elapsed between ingestion and hospital arrival, symptoms, and first aid measures taken at home. A complete clinical examination was performed in all children with special attention to respiratory and neurological findings.

Clinical severity was assessed using parameters such as respiratory distress, cyanosis, tachypnea, fever, cough, vomiting, chest retractions, altered sensorium, and oxygen saturation. Gupta's scoring system was used for assessment of clinical severity and prognosis.

Nutritional assessment was performed using anthropometric measurements including weight, height/length, and mid-upper arm circumference. Nutritional status was classified according to WHO growth standards. Children with weight-for-height Z score below −3 SD were classified as severe acute malnutrition.

Chest radiography was performed in all children approximately 6 hours after ingestion or earlier if clinically indicated. Repeat chest X-rays were obtained in cases with worsening respiratory symptoms. Radiological findings were assessed and graded according to Foley's criteria as:

- Grade I - Normal radiograph
- Grade II - Less than 10% lung involvement
- Grade III - 10-30% lung involvement
- Grade IV - More than 30% lung involvement

Supportive treatment including oxygen therapy, intravenous fluids, antibiotics, bronchodilators, and ventilatory support when required was provided according to the clinical condition of the child. All children were monitored throughout hospitalization for complications and outcome.

Sample Processing

Blood samples were collected under aseptic precautions for laboratory investigations including complete blood count and arterial blood gas analysis wherever indicated. Chest radiographs were interpreted by experienced radiologists and pediatricians. Nutritional assessment data were processed using WHO growth charts and Z-score calculations.

Statistical Methods

The collected data were entered into Microsoft Excel and analyzed using Statistical Package for Social Sciences (SPSS) software version 25.0. Descriptive statistics such as mean, standard deviation, frequency, and percentage were used for data presentation. Chi-square test was used to assess association between categorical variables. Student's t-test was used for comparison of quantitative variables between groups. Correlation analysis was performed to determine the relationship between radiological lung involvement, clinical severity, and nutritional status. A p-value of less than 0.05 was considered statistically significant.

Data Collection

Data were collected using a structured case record form designed for the study. Information regarding demographic profile, clinical presentation, nutritional status, radiological findings, laboratory parameters, treatment received, duration of hospital stay, complications, and outcome were systematically recorded for each participant. Continuous monitoring and follow-up were performed until discharge or death.

RESULTS

Table 1: Correlation of Radiological Lung Involvement with Clinical Severity and Nutritional Status in Children with Kerosene Poisoning (n=110)

Variable	n (%) / Mean(SD)	95% CI	Test of significance	p-value
Age	3.11 ± 0.63 years	2.99-3.23	Descriptive	
Radiological pneumonitis present	74 (67.3%)	58.1-75.3	Chi-square	<0.001
Normal chest X-ray	39 (35.5%)	27.1-44.7	Chi-square	
Foley Grade IV lung involvement	26 (23.6%)	16.7-32.4	Chi-square	<0.001
Symptomatic children	95 (86.4%)	78.7-91.6	Chi-square	<0.001
Severe acute malnutrition	45 (40.9%)	32.2-50.3	Chi-square	0.001
Prolonged hospital stay >3 days	24 (21.8%)	15.1-30.4	Chi-square	<0.001
Mortality	2 (1.8%)	0.5-6.4	Fisher's exact test	0.498

Table 1 shows the correlation of radiological lung involvement with clinical severity and nutritional status among 110 children with kerosene poisoning. The mean age of the study population was 3.11 ± 0.63 years (95% CI: 2.99-3.23 years), indicating that kerosene poisoning was predominantly observed in toddlers and preschool children. Radiological pneumonitis was present in 74 (67.3%) children and this association was statistically significant (p<0.001). Normal chest X-ray findings were observed in 39 (35.5%) children. Severe radiological involvement according to Foley Grade IV was noted in 26 (23.6%) children, which also showed strong statistical significance (p<0.001). A large majority of children, 95 (86.4%), were symptomatic at presentation and this association with radiological involvement was highly significant (p<0.001). Severe acute malnutrition (SAM) was present in 45 (40.9%) children and demonstrated significant correlation with radiological severity (p=0.001). Prolonged hospital stay of more than 3 days was observed in 24 (21.8%) children and was significantly associated with severe lung involvement (p<0.001). Mortality was recorded in 2 (1.8%) children; however, this association was not statistically significant (p=0.498).

Table 2: Radiological Lung Involvement in Children with Kerosene Poisoning Using Foley's Criteria (n=110)

Foley's radiological grade	Lung involvement	n (%)	95% CI	Test of significance	p-value
Grade I	Normal radiograph	39 (35.5%)	27.1-44.7	Chi-square goodness of fit	<0.001
Grade II	<10% lung involvement	25 (22.7%)	15.9-31.4		
Grade III	10-30% lung involvement	20 (18.2%)	12.1-26.4		
Grade IV	>30% lung involvement	26 (23.6%)	16.7-32.4		
Total		110 (100.0%)			

Table 2 depicts the distribution of radiological lung involvement in children with kerosene poisoning according to Foley's criteria. Grade I radiological involvement, representing normal chest radiograph, was observed in 39 (35.5%) children. Grade II involvement with less than 10% lung involvement was seen in 25 (22.7%) children, while Grade III involvement involving 10-30% of lung fields was observed in 20 (18.2%) children. Severe radiological involvement, classified as Grade IV with more than 30% lung involvement, was present in 26 (23.6%) children. The distribution of radiological grades showed statistical significance by Chi-square goodness of fit test (p<0.001). Overall, abnormal radiological findings were present in 71 (64.5%) children, indicating that pulmonary involvement was a common complication of kerosene poisoning.

Table 3: Association Between Radiological Lung Involvement and Clinical Severity (n=110)

Duration of hospital stay	Grade I Normal n(%)	Grade II <10% n(%)	Grade III 10-30% n(%)	Grade IV >30% n(%)	Test of significance	p-value
1-3 days	39 (35.5%)	25 (22.7%)	16 (14.5%)	8 (7.3%)	$\chi^2 = 58.04$	<0.001
4-6 days	0	0	3 (2.7%)	7 (6.4%)		
7-10 days	0	0	1 (0.9%)	9 (8.2%)		
>10 days	0	0	0	2 (1.8%)		
Total	39 (35.5%)	25 (22.7%)	20 (18.2%)	26 (23.6%)		

Table 3 demonstrates the association between radiological lung involvement and duration of hospital stay among children with kerosene poisoning. Among children with Grade I normal radiographs, all 39 (35.5%) children improved within 1-3 days of hospitalization. Similarly, all 25 (22.7%) children with Grade II lung involvement recovered within 1-3 days. In contrast, children with Grade III and Grade IV involvement showed progressively prolonged hospitalization. Of the Grade III cases, 16 (14.5%) recovered within 1-3 days, while 3 (2.7%) stayed for 4-6 days and 1 (0.9%) required hospitalization for 7-10 days. Among Grade IV cases, only 8 (7.3%) recovered within 1-3 days, whereas 7 (6.4%) stayed for 4-6 days, 9 (8.2%) required 7-10 days of hospitalization, and 2 (1.8%) remained hospitalized for more than 10 days. The association between increasing Foley radiological grade and prolonged hospital stay was highly significant ($\chi^2 = 58.04$, p<0.001).

Table 4: Correlation Between Nutritional Status and Severity of Radiological Lung Involvement (n=110)

Nutritional status	Grade I Normal n(%)	Grade II <10% n(%)	Grade III 10-30% n(%)	Grade IV >30% n(%)	Test of significance	p-value
SAM present	9 (8.2%)	9 (8.2%)	8 (7.3%)	19 (17.3%)	$\chi^2 = 16.52$	0.001
SAM absent	30 (27.3%)	16 (14.5%)	12 (10.9%)	7 (6.4%)		
Total	39 (35.5%)	25 (22.7%)	20 (18.2%)	26 (23.6%)		

Additional measure: Odds of Grade IV involvement were higher in SAM children: OR = 6.05, 95% CI = 2.27-16.17.

Table 4 shows the correlation between nutritional status and severity of radiological lung involvement in children with kerosene poisoning. Among children with severe acute malnutrition (SAM), Grade IV radiological involvement was observed in 19 (17.3%) children, compared to only 7 (6.4%) children without SAM. Grade I normal radiographs were more common among children without SAM [30 (27.3%)] than among those with SAM [9 (8.2%)]. Similarly, Grade II and Grade III involvement were also distributed more frequently among malnourished children. The association between nutritional status and radiological severity was statistically significant ($\chi^2 = 16.52$, p=0.001). Furthermore, the odds ratio analysis demonstrated that children with SAM had significantly higher odds of developing severe Grade IV lung involvement (OR = 6.05, 95% CI: 2.27-16.17).

DISCUSSION

In the present study, the mean age of children was 3.11±0.63 years, indicating that kerosene poisoning was most common in younger children. This finding is comparable with Sunilkumar et al.(2016)[1], who reported peak incidence in early childhood due to curiosity, mouthing behavior, and easy household accessibility of kerosene. Slima et al.(2021)[2] also observed that most affected children were below 3 years of age, supporting the observation that toddlers are the most vulnerable group. Maheshwari et al.(2018)[3] similarly emphasized that accidental hydrocarbon ingestion is predominantly seen in toddlers because of unsafe storage practices and inadequate supervision at home. Parekh et al.(2017)[7] further noted that children between 1-3 years constituted the largest proportion of kerosene poisoning admissions in tertiary care hospitals.

Radiological pneumonitis was present in 74 (67.3%) children, while 39 (35.5%) had normal chest radiographs. Similar findings were reported by Kaka et al.(2025)[4], who observed radiological pulmonary involvement in a majority of children with petroleum intoxication. Kumar et al.(2019)[5] also documented radiological abnormalities such as lower lobe infiltrates and bronchopneumonia in a substantial proportion of children with hydrocarbon poisoning. In the present study, 26 (23.6%) children had Foley Grade IV involvement, suggesting severe pulmonary injury. This supports Lee et al.(2019)[6], who emphasized that the extent of radiological involvement has prognostic importance in hydrocarbon aspiration and correlates with severity of pulmonary damage. Palmer et al.(2019)[8] similarly described that aspiration-induced acute lung injury may range from mild infiltrates to diffuse bilateral involvement depending on the severity of aspiration.

The present study showed that 95 (86.4%) children were symptomatic, with significant association between symptoms and radiological involvement (p<0.001). This is consistent with Slima et al.(2021)[2], who reported cough, dyspnea, tachypnea, and vomiting as major presenting features in acute kerosene poisoning. Sunilkumar et al.(2016)[1] also observed that respiratory manifestations were the dominant clinical features and were closely related to radiological pneumonitis. Dey et al.(2025)[10] similarly reported that respiratory distress and abnormal chest findings were significantly associated with adverse outcomes in hydrocarbon poisoning.

Increasing Foley grade was significantly associated with prolonged hospital stay (χ^2=58.04, p<0.001). All children with Grade I and Grade II involvement recovered within 1-3 days, whereas Grade IV cases frequently required longer hospitalization. Sunilkumar et al.(2016)[1] similarly reported a positive correlation between extent of radiological involvement and duration of hospital stay. Kaka et al.(2025)[4] also noted that children with severe pulmonary involvement required prolonged oxygen therapy and intensive supportive care. Palmer et al.(2019)[8] further explained that extensive aspiration injury leads to alveolar inflammation, surfactant dysfunction, and delayed pulmonary recovery, thereby increasing hospitalization duration.

Severe acute malnutrition was present in 45 (40.9%) children and showed significant association with severe radiological lung involvement (χ^2=16.52, p=0.001). Grade IV involvement was seen more commonly in SAM children, and the odds of Grade IV disease were 6.05 times higher among malnourished children. This finding is clinically important because malnutrition reduces respiratory reserve, immunity, and recovery capacity. Lee et al.(2019)[6] described that children with poor nutritional status are more susceptible to severe aspiration-induced lung injury and secondary infections. Kumar et al.(2019)[5] also emphasized that malnourished children tend to develop greater respiratory compromise and delayed clinical improvement following hydrocarbon aspiration.

Mortality was observed in 2 (1.8%) children, but the association was not statistically significant (p=0.498). Dey et al.(2025)[10] also reported low mortality in kerosene poisoning, with deaths usually occurring due to severe aspiration pneumonitis, encephalopathy, or respiratory failure. Balme et al.(2015)[9] similarly noted that although mortality is generally low with appropriate supportive treatment, severe pulmonary complications may occasionally lead to fatal outcomes.

CONCLUSION

The present study demonstrated that radiological lung involvement is a common and clinically significant complication in children with kerosene poisoning. The majority of affected children were below 5 years of age, highlighting the vulnerability of toddlers due to unsafe storage practices and accidental ingestion. Radiological pneumonitis was observed in a substantial proportion of children, with parahilar infiltrates and varying grades of lung involvement according to Foley's criteria being the common findings.

A significant association was observed between the severity of radiological lung involvement and clinical severity. Children with higher Foley grades had more pronounced symptoms, prolonged hospital stay, and greater morbidity. Grade IV radiological involvement was strongly associated with delayed recovery and increased need for supportive management. Severe acute malnutrition also showed a significant correlation with severe radiological lung involvement, suggesting that malnourished children are at higher risk of developing severe pulmonary complications following kerosene aspiration.

The study emphasizes the importance of early clinical evaluation, radiological assessment, and nutritional status assessment in all children presenting with kerosene poisoning. Foley's radiological grading can serve as a useful prognostic tool for predicting disease severity and duration of hospitalization. Early recognition and prompt supportive treatment can help reduce morbidity and improve outcomes in affected children.

LIMITATIONS OF THE STUDY

1. The study was conducted at a single tertiary care center, limiting generalizability of the findings to the wider population.
2. The sample size was relatively small, which may affect the statistical strength of some associations.
3. Long-term pulmonary follow-up of children was not performed to assess residual respiratory complications.
4. Quantification of exact amount of kerosene ingested depended on parental recall and may be subject to recall bias.
5. Advanced imaging modalities such as CT chest were not performed in all cases.
6. Nutritional assessment was based mainly on anthropometric measurements without detailed biochemical evaluation.
7. Some asymptomatic children may have developed delayed radiological changes after discharge which could not be evaluated.
8. Environmental and socioeconomic confounding factors influencing severity could not be completely controlled.

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