# Adrenocorticosteroid treatment of hydrocarbon pneumonia in children—a cooperative study

*A cooperative study at three children's hospitals was devised to evaluate the efficacy of adrenocorticosteroid treatment in hydrocarbon pneumonitis of children. The drug used was methylprednisolone, and the study design was double-blind controlled. Seventy-one patients were completely studied. No differences were demonstrated between the groups when comparisons were made for the number of days with abnormal temperature, abnormal respiratory rate, abnormal pulse, and the number of days of hospitalization. Similarly, no differences were discernible when the subjective assessment of the patient morbidity rate and the radiographic changes were analyzed. Only three patients in the group were classified as having a severe pneumonitis; there were no deaths. Although mostly mild and moderate cases of hydrocarbon pneumonitis were evaluated in the present investigation, the results do not support the use of adrenocorticosteroids in the treatment of this condition.*

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INGESTION of hydrocarbon distillates is the second most common childhood poisoning in the United States[1] and may be associated with a significant morbidity rate.[2] The clinical and pathologic manifestations of hydrocarbon poisoning have been well described; pulmonary complications are the most significant.[3-5] Although still controversial, much clinical and experimental evidence supports the hypothesis that the pneumonia associated with ingestion of hydrocarbons is due to the aspiration of the product; many authorities therefore advise against the induction of vomiting and/or gastric lavage.[6-10] Despite adherence to these principles, a significant proportion of children ingesting hydrocarbon distillates develop a chemical pneumonitis. The purpose of this investigation was to study the effect of treatment of hydrocarbon pneumonia with adrenocorticosteroids in a double-blind controlled manner.

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## METHODS AND MATERIALS

A standard protocol was devised for use in the three cooperating hospitals: The Montreal Children's Hospital, The Hôpital Ste-Justine of Montreal, and The Children's Hospital of Halifax, Nova Scotia. Children

**Table I.** Details of patients treated

| Treatment | Clinical severity* | | | Radiologic severity* | | | Total No. |
|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 1 | 2 | 3 | |
| Drug | 29 | 5 | 2 | 28 | 7 | 1 | 36 |
| Placebo | 24 | 10 | 1 | 27 | 7 | 1 | 35 |

* 1 = mild, 2 = moderate, 3 = severe.

were admitted to the study according to the following criteria: (1) admission to the hospital, (2) history of hydrocarbon ingestion, and (3) radiologic plus clinical evidence of pulmonary involvement. Hydrocarbons were defined as any of the following petroleum distillate products: kerosene, lemon oil, naphtha, mineral spirits (Varsol), gasoline, furniture polishes, and charcoal lighter fluid. Turpentine and other highly volatile petroleum distillate products were excluded.

Upon admission to the study the patient's history and physical examination were completed, and he was randomly assigned to drug or placebo treatment. The drug was similar in appearance and packaging to the placebo (lactose); the treatment of any child was not known to any of the participants of the study. The drug was methylprednisolone sodium succinate (The Upjohn Co.); 48 mg. per square meter per day were administered orally or intramuscularly for a period of three days. In addition to the drug or placebo all patients received penicillin and supportive respiratory care, including placement in a Croupette with humidified air or oxygen as required.

Chest radiographs were obtained 6 to 12 hours after admission, at 72 hours, and at the time of discharge from the hospital. In addition, the patient's temperature, sleeping respiration and pulse rates, and general condition were recorded at least every six hours. Abnormal temperature was defined as $>$ 100° F. per rectum and $>$ 99° F. orally; sleeping respirations were abnormal if above 40 per minute for children ages 0 to 1 year and $>$30 per minute for older children; sleeping pulse was abnormal if $>$ 140 (0 to 1 year), $>$ 130 (1 to 2 years), and $>$ 120 (older than 2 years). Criteria for discharge from hospital included normal temperature, pulse and respirations, and general condition judged satisfactorily by the attending physician. All data were recorded on study report forms and verified by one of the authors.

**Table II.** Comparison of objective criteria measured in all patients

| Criteria | Drug = 36 patients | Placebo = 35 patients | Significance |
|---|---|---|---|
| Mean No. days with elevated temperature | 1.50 | 1.00 | P = $>$ 0.3 |
| Mean No. days with elevated respiratory rate | 1.34 | 1.48 | P = $>$ 0.7 |
| Mean No. days with elevated pulse | 1.79 | 1.46 | P = $>$ 0.6 |
| Mean No. days in hospital | 3.94 | 3.95 | P = $>$ 0.9 |

## RESULTS

Seventy-one of the 89 children admitted to the study fulfilled the criteria for inclusion outlined above and had complete data for analysis. Patients excluded were those with inaccurate histories, medication errors, and inadequate recording of vital signs, radiographs, or clinical findings. There were 49 males included in the analyses; their average age was 24 months. Twenty-five patients vomited spontaneously, and five were induced to vomit at home; two received gastric lavage. These patients were evenly distributed within the drug and placebo groups.

Kerosene and mineral spirits (Varsol) were the products most frequently ingested. The quantity of hydrocarbon ingested was difficult to estimate accurately in most cases and could usually only be described as "a mouthful" or similar estimate. In four patients the estimated quantity was 3 to 4 ounces; their courses did not differ appreciably from those of the others. Seven patients had central nervous system signs at the time of admission: three were drowsy, two were irritable, one was ataxic, and one had tremors. In all instances these symptoms were

**Table III.** Analysis of groups by clinical severity

| | *Drug group severity** | | | *Placebo group severity** | | |
|---|---|---|---|---|---|---|
| *Mean No. days* | *1 = (29 patients)* | *2 = (5 patients)* | *3 = (2 patients)* | *1 = (24 patients)* | *2 = (10 patients)* | *3 = (1 patient)* |
| Elevated temperature | 1.05 | 2.14 | 6.5 | 1.00 | 2.03 | 0.75 |
| Increased respirations | 0.97 | 1.87 | 6.5 | 0.79 | 2.47 | 10 |
| Increased pulse | 1.44 | 1.95 | 6.5 | 0.86 | 2.35 | 8 |
| In hospital | 3.36 | 4.50 | 9.5 | 3.27 | 4.45 | 18 |

*1 = mild, 2 = moderate, 3 = severe.

**Table IV.** Analysis of groups by radiologic severity

| | *Drug group severity* | | | *Placebo group severity* | | |
|---|---|---|---|---|---|---|
| *Mean No. days* | *1 = (28 patients)* | *2 = (7 patients)* | *3 = (1 patient)* | *1 = (27 patients)* | *2 = (7 patients)* | *3 = (1 patient)* |
| Elevated temperature | 1.12 | 2.23 | 7.0 | 1.34 | 1.19 | 0.75 |
| Increased respirations | 1.01 | 1.72 | 7.0 | 1.24 | 1.35 | 10 |
| Increased pulse | 1.49 | 2.10 | 7.0 | 1.31 | 1.33 | 8 |
| In hospital | 3.31 | 7.43 | 10 | 3.64 | 3.64 | 18 |

transient, and no neurological sequelae were noted. There were 36 patients in the drug group and 35 in the placebo group. These were divided into three subgroups on the basis of clinical severity and into three on the basis of radiologic abnormalities (Table I).

The number of days with abnormal temperature, abnormal respiratory rate, abnormal pulse, and the number of days in the hospital are shown in Table II. There were no significant differences in these data between the drug and placebo groups. When these results are further analyzed according to the severity of disease, as judged by clinical and radiologic characteristics, again no significant differences are noted (Tables III and IV). Of importance, however, is the fact that the illness of most patients was categorized as mild or moderate; only three children were considered to have severe hydrocarbon pneumonitis.

Other parameters used to follow the course of these patients' illnesses included a clinical assessment by the attending physician and study supervisor and the radiologic changes during the patient's course. These measurements could not be quantitated easily. When the crude criteria of mild, moderate, or severe were used to estimate the clinical and radiologic changes, no obvious differences were noted between the drug and placebo groups. There were also no differences in the evolution of the radiologic changes between the two groups. No differences were noted when the route of administration (i.e., oral versus intramuscular) was considered in the analysis.

## DISCUSSION

The clinical characteristics and pathogenesis of hydrocarbon pneumonia have been well described in both the human patient and the experimental animal model.[5, 7-9] The results of treatment in five cases reported in the literature suggested that adrenocorticosteroids may have a beneficial effect on the course of hydrocarbon pneumonias[11-15]; in one additional instance the patient died.[16] A controlled study carried out in Baltimore did not seem to support these observations.[17] Twenty-one children with kerosene ingestion were studied. Prednisone 40 mg. per day for 3 days was administered to alternate patients; no differences were detected in the duration of hospitalization or radiologic evolution of disease.[17] The present investigation, though limited in scope and applicability by its preponderance of mild and moderate cases, does not support the use of adrenocorticosteroids in the treatment of hydrocarbon pneumonia. This would con-

firm the clinical observations of Hardman and associates[17] and the experimental observations in the rat model with kerosene-induced pneumonitis as described by Albert and Inkley.[18] These latter investigators administered methylprednisolone just before intratracheal administration of kerosene and once a day thereafter. They were unable to demonstrate any difference in case fatality rates in animals treated with the steroid and in those treated with an antibiotic alone.

A retrospective analysis of patients admitted to the Montreal Children's Hospital with hydrocarbon pneumonia was carried out for the period 1959 to 1965 and provided the background material for devising the present study protocol. Forty-one patients were seen during this time; there were no deaths, and the average hospital stay was 5.5 days. A steroid was administered to only one child, and his clinical course did not appear to be significantly different from that of the other children. Together with the 71 cases reported herein and the experience of others, it appears that hydrocarbon pneumonia in the United States and Canada at this time is most often of the mild to moderate degree of severity with very few severe cases and a negligible mortality rate. Improvement in the mortality rate associated with this condition is most probably attributable to the quality of supportive care that has evolved in major medical centers across North America in recent years. Thus the use of adrenocorticosteroids in the majority of children with hydrocarbon pneumonia in North America does not appear to be justified by the evidence available.

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