**Brief Report**

# Carbon Monoxide Poisoning From Indoor Burning of Charcoal Briquets

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**Objective.**—To describe the case characteristics of a series of patients poisoned with carbon monoxide (CO) resulting from indoor burning of charcoal briquets.

**Design.**—Cases of patients with unintentional CO poisoning referred for treatment with hyperbaric oxygen were reviewed. Cases that occurred as the result of indoor burning of charcoal briquets were analyzed.

**Setting.**—A private, urban, tertiary care center.

**Patients.**—Seventy-nine patients ranging from 3 months to 87 years of age referred from 10 counties within the state of Washington between October 1982 and October 1993.

**Results.**—Of 509 patients treated for acute unintentional CO poisoning, 79 cases occurred in 32 incidents as a result of indoor burning of charcoal briquets, for the purpose of either home heating or cooking. A majority of cases occurred in the months of October through January, commonly during power outages or when electricity was intentionally disconnected. Patients of minority races were disproportionately represented compared with the general population of the region.

**Conclusions.**—Carbon monoxide poisoning is a significant hazard from indoor use of charcoal briquets. All cases are avoidable and public awareness of the risk should be enhanced.

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CARBON monoxide (CO) intoxication can cause injury to hypoxia-sensitive tissues such as the brain and the heart, resulting in permanent damage or death.[1] In addition, delayed neurologic deterioration following significant CO exposure may also occur after a lucid interval ranging from 2 days to 6 weeks.

The death rate from unintentional CO poisoning declined in the United States during the 1980s, due in part to public education and enhanced awareness of activities associated with this risk.[2] Nonetheless, CO intoxication remains common in this country with an estimated 10 000 persons seeking medical attention or missing at least 1 day of normal activity because of the syndrome annually.[3] In addition, 800 to 1000 deaths occur each year making it the most common cause of unintentional poisoning death in the United States.[2]

Many cases of CO poisoning result from activities not recognized to be hazardous by the victim.[4] Because charcoal briquets appear visually to burn cleanly, individuals are often unaware that they emit significant quantities of CO. Cases of CO exposure from indoor burning of charcoal briquets have been reported,[5-13] but no previous study has described this number of patients, their epidemiology, and reasons for indoor charcoal briquet use.

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## Methods

Records of patients treated for CO poisoning in the Hyperbaric Department of Virginia Mason Medical Center in Seattle, Wash, from October 1982 to October 1993 were reviewed. A case of CO poisoning was defined as an individual with a history of CO exposure, symptoms consistent with CO intoxication, and an elevated blood carboxyhemoglobin (COHb) level.[14] To receive hyperbaric oxygen treatment, patients were required to demonstrate significant CO intoxication, manifested by (1) a COHb level of 25% or greater, (2) anginal pain or ischemic changes on electrocardiogram, or (3) neurological impairment, including transient loss of consciousness.

Unintentional CO poisonings that occurred as a result of indoor burning of charcoal briquets were selected for this report. Information on individual cases was collected from emergency department and hyperbaric department records.

Carboxyhemoglobin levels reported represent those values measured during initial emergency department evaluation, sometimes at a facility outside our institution. Prior to obtaining blood samples for COHb determination, all patients had been removed from the source of CO exposure and many received supplemental oxygen during transfer.

Patients were treated with hyperbaric oxygen in a multiplace hyperbaric chamber. Treatment consisted of hyperbaric oxygen administration at 2.8 to 3.0 atmospheres absolute pressure. Duration of treatment was based on the severity of clinical presentation. Additional standard medical care was provided as appropriate.

## Results

During the time reviewed, 509 patients were treated on an emergency basis for acute unintentional CO poisoning. Of these, 79 (16%) were exposed to CO originating from the indoor burning of charcoal briquets in a total of 32 separate incidents. More than one individual was poisoned in 69% of incidents (Table 1). Poisonings demonstrated a seasonal distribution with 24 incidents (75%) occurring during the 4-month period from October through January.

Patient ages ranged from 3 months to 87 years (median age, 29 years). Males (48%) and females (52%) presented with equal frequency. Racial and ethnic minorities accounted for 58 (73%) of the total patients (Table 2). While all black and non-Hispanic white patients spoke English, 21 (88%) of 24 Hispanic white patients and 13 (56%) of 23 Asian patients did not.

Carboxyhemoglobin levels for all patients ranged from 3.0% to 45.8%, averaging 21.6% ± 9.6% (mean ± SD). Loss of consciousness occurred at least transiently in 26 (33%) of the patients. Other symptoms occurring in more than 25% of patients were headache (67%), nausea (54%), vomiting (35%), and dizziness (27%). Less frequent symptoms included lethargy, abdominal pain, confusion, weakness, dyspnea, chest pain, ataxia, seizures, euphoria, irritability, and incontinence.

With regard to circumstances of exposure, the activity associated with indoor charcoal burning was home heating in 16 incidents and cooking in 16 incidents. Loss of consciousness occurred with equal frequency in each type of exposure.

The reason for indoor use of charcoal

Table 1.—Number of Individuals Poisoned With Carbon Monoxide From Indoor Use of Charcoal Briquets per Exposure Incident

| Individuals Poisoned per Incident | No. of Incidents |
|---|---|
| 1 | 10 |
| 2 | 11 |
| 3 | 4 |
| 4 | 5 |
| 6 | 1 |
| 9 | 1 |

Table 2.—Race/Ethnicity of Patients With Carbon Monoxide Poisoning Due to Indoor Burning of Charcoal Briquets, Compared With Racial/Ethnic Composition of General Population of Counties of Occurrence*

| Race/Ethnicity | No. of Patients (% of Total) | Regional Census, % |
|---|---|---|
| Hispanic white | 24 (30) | 1.7 |
| Asian | 23 (29) | 5.5 |
| Non-Hispanic white | 21 (27) | 85.0 |
| Black | 3 (4) | 4.1 |
| Other | 8 (10) | 3.8 |

*Data from 1990 United States Census.

briquets could be determined from the records of 17 incidents. Loss of electrical power to the house was commonly identified, due to a local power outage (storms and the like) in 13 incidents and resulting from intentional discontinuation of service by the utility company in two incidents. Absence of otherwise functional heating or cooking facilities within the house accounted for two incidents.

## Comment

These cases demonstrate that individuals who burn charcoal briquets indoors are at risk for CO poisoning. Previous reports of similar cases have described small numbers of patients, possibly leading to the conclusion that such activity is uncommon, or have reported cases from reviews of death records, allowing only speculation as to the reasons for indoor charcoal usage.[5-13] This study reports the largest series of patients poisoned in this fashion and examines reasons for indoor charcoal briquet use, as well as potential risk factors for this activity.

The use of charcoal grills is popular in the United States, although the frequency of indoor use is unknown. According to the Barbecue Industry Association, 44 million American households owned a charcoal grill in 1989. It is estimated that 600 million charcoal-barbecuing events are performed annually, consuming approximately 750 000 tons of charcoal.

Despite the fact that charcoal briquets appear visually to burn cleanly, combustion of briquets does produce significant amounts of CO. The Occupational Safety and Health Administration defines the maximal safe level for instantaneous CO exposure in the workplace as 200 ppm.[15] The air stream from charcoal grills has been shown to contain 20 to 2000 ppm of CO, with 75% of grills emitting 200 ppm and above.[16]

Carbon monoxide poisoning due to indoor burning of charcoal is common in Korea where over 70% of households use briquets for home heating and cooking.[17] Minority race patients comprised 73% of the patients seen in the present series, disproportionate to the racial and ethnic composition of the counties from which these patients were referred. This suggests that social and/or economic factors contributed to indoor charcoal use. Previous reports of CO poisoning from charcoal briquets have also noted that patients were of minority races and/or non-English speaking.[11-13] Many of our minority patients were first-generation immigrants, continuing to practice ethnic customs without awareness of the risk of such activities. While socioeconomic status of patients was not analyzed, the possibility that minority race was a marker for low socioeconomic status should be considered.

It should be emphasized that manufacturers of charcoal briquets do not intend them for indoor use. A standard warning is prominently printed on all packages of briquets produced for domestic use that reads, "Warning—Do not use for indoor heating or cooking unless ventilation is provided for exhausting fumes to outside. Toxic fumes may accumulate and cause death." Despite this warning, which has been required since 1971,[18] CO intoxication from indoor burning of charcoal briquets continues to occur. In the present study, many patients did not speak English, probably contributing to their disproportionate representation.

The incidence of this problem is unknown, but it is likely that additional cases of similar or lesser severity occurred during the same time period and were not referred for treatment, owing to either lack of need for hyperbaric oxygen or failure to recognize the syndrome. Typical symptoms experienced by patients can easily be attributed to other causes by both physicians and patients. Misdiagnosis of CO poisoning by physicians is well described.[19,20] Many of the patients in our series who burned charcoal indoors for cooking initially suspected food poisoning.

Charcoal briquets were frequently burned indoors when electrical power supply to the house was disrupted, due either to regional power outages from storms or to intentional disconnection by the utility company for unpaid bills. The risk of CO poisoning from such activity should be widely publicized by the media at times of power outages. In addition, inclusion of a warning with notification of intent to disconnect electrical service by the utility company seems reasonable.

In addition to public warnings during loss of electrical power, improved public education is needed. This is especially true for minority populations, as they appear at increased risk. The warning printed on bags of charcoal briquets is currently being reviewed by the US Consumer Product Safety Commission for possible clarification and revision. Such revision must take into account the fact that many persons poisoned by charcoal briquets do not speak English. Possible solutions would include multilingual warnings or the inclusion of a nonverbal graphic warning.

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