perfusion through a 100 g charcoal column at a 350 ml/min. flow rate. Similar result was obtained when Ringer’s solution was used instead of blood.

Perfusion through 100 g of charcoal at 250 ml/min. almost completely removed 500 mg of glutethimide from one litre of blood within 15 minutes.

In single pass experiment using 100 l of aqueous solution with an inflow glutethimide concentration of 10 mg/100 ml, with a flow rate of 100 ml/min., saturation of 100 g of charcoal, as judged by a sharp decrease in extraction ratio, occurred after 420 min. perfusion, indicating that approximately 4.2 g of glutethimide would saturate 100 g of charcoal.

Comparison between charcoal adsorption and haemodialysis extraction for glutethimide showed a removal rate much higher for charcoal than for haemodialysis as judged by comparison of the declining slopes observed during these two procedures. When plotted on semilogarithmic scale the serum half-life during haemodialysis is about 7 times longer than during charcoal haemoperfusion (De Myttenaere et al., 1967).

IN VIVO STUDIES

The same extracorporeal charcoal haemoperfusion technique (Fig. 2) was used in 6 dogs after ingestion of 400 mg of glutethimide/kg. Four animals underwent charcoal haemoperfusion for about 2 hours; two served as controls. All four treated animals awakened promptly after haemoperfusion, but the two control dogs, poisoned with the same dosage, died without regaining consciousness.

The evolution of glutethimide blood levels is shown in Figure 3.

Of four dogs poisoned with Veronal (150 mg/kg), two underwent one hour charcoal haemoperfusion, awakened and survived. Two served as control and were not treated: one died and

Fig. 2. The in vivo circuit includes vessel cannulae, manometer and column containing charcoal and appropriate filters.
HAEMOPERFUSION THROUGH A CHARCOAL COLUMN FOR TREATMENT OF POISONING

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The need for a safe and inexpensive method of haemodialysis is apparent. A non-dialytic method has been evaluated for removal of glutethimide (Doriden) and barbital (Veronal) from the blood.

The cost and simplicity of the Yatzidis (1964) extracorporeal haemoperfusion system, consisting in a column containing activated charcoal, merit serious attention.

IN VITRO STUDIES

To evaluate the adsorptive capacity of charcoal, preliminary in vitro studies were performed on saline and on outdated human blood containing known amounts of barbiturates or glutethimide. In a closed circuit, the solution was passed through a charcoal column (100 g) by a circulating pump and returned to a reservoir (Fig. 1). Barbital and glutethimide were readily adsorbed on the charcoal.

For barbiturates in a closed circuit and for concentrations as high as 50 mg/100 ml in outdated blood, less than 10% of initial values were found in the reservoir after 15 min. of

Fig. 1. The in vitro charcoal perfusion circuit.
Fig. 3. Glutethimide serum levels in 4 treated dogs (■) and 2 control untreated dogs (▲). All were poisoned with 400 mg/kg of glutethimide 10 to 11 hours before charcoal haemoperfusion (△△△△). Arrows (i) indicate time of awakening. The 4 treated animals survived. The 2 control animals died.

the other remained in coma for 18 hours. The evolution of serum barbiturate levels is shown in Figure 4.

With 200 g of charcoal, in vivo glutethimide clearances ranged from 84 to 150 ml/min., and usually approached the flow rates, indicating nearly complete extraction by the perfusion apparatus (De Myttenaere et al., 1967). For barbital, in vivo clearances amounted to 103 to 116 ml/min. in the dog. These values are approximately ten times greater than those obtained with haemodialysis.

The charcoal haemoperfusion appears relatively safe despite the occurrence of thrombocytopenia due to platelet adherence or destruction on charcoal. This, however, never led to abnormal bleeding (Dunca and Kolff, 1965).

The very high adsorption rate for glutethimide and barbiturates allows consideration of charcoal haemoperfusion for therapy of severe poisoning.
Fig. 4. Barbiturate serum levels in 2 dogs (●) treated by 1 hour charcoal haemoperfusion (□) and in 2 control untreated dogs (▲). Arrows indicate time of awakening. The 2 treated animals survived. One control dog died. The other underwent 18 hours' coma.

REFERENCES

