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Hydrogen gas inhalation inhibits progression to the "irreversible" stage of shock after severe hemorrhage in rats

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Abstract

Background: Mortality of hemorrhagic shock primarily depends on whether or not the patients can endure the loss of circulating volume until radical treatment is applied. We investigated whether hydrogen (H2) gas inhalation would influence the tolerance to hemorrhagic shock and improve survival.

Methods: Hemorrhagic shock was achieved by withdrawing blood until the mean arterial blood pressure reached 30-35 mm Hg. After 60 minutes of shock, the rats were resuscitated with a volume of normal saline equal to four times the volume of shed blood. The rats were assigned to either the H2 gas (1.3% H2, 26% O2, 72.7% N2)-treated group or the control gas (26% O2, 74% N2)-treated group. Inhalation of the specified gas mixture began at the initiation of blood withdrawal and continued for 2 hours after fluid resuscitation.

Results: The survival rate at 6 hours after fluid resuscitation was 80% in H2 gas-treated rats and 30% in control gas-treated rats ($p < 0.05$). The volume of blood that was removed through a catheter to induce shock was significantly larger in the H2 gas-treated rats than in the control rats. Despite losing more blood, the increase in serum potassium levels was suppressed in the H2 gas-treated rats after 60 minutes of shock. Fluid resuscitation completely restored blood pressure in the H2 gas-treated rats, whereas it failed to fully restore the blood pressure in the control gas-treated rats. At 2 hours after fluid resuscitation, blood pressure remained in the normal range and metabolic acidosis was well compensated in the H2 gas-treated rats, whereas we observed decreased blood pressure and uncompensated metabolic acidosis and hyperkalemia in the surviving control gas-treated rats.

Conclusions: H2 gas inhalation delays the progression to irreversible shock. Clinically, H2 gas inhalation is expected to stabilize the subject until curative treatment can be performed, thereby increasing the probability of survival after hemorrhagic shock.

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