

CLINICAL REPORTS

Ronald D. Miller, M.D., Editor

Anesthesiology
63:316-317, 1985

Gas Embolism Produced by Hydrogen Peroxide Irrigation of an Anal Fistula during Anesthesia

SHEN-KOU TSAI, M.D.,* TAK-YU LEE, M.D.,* MARTIN S. MOK, M.D.†

Hydrogen peroxide is used to cleanse a wound by bubbling out foreign material. The effervescence caused by the release of nascent oxygen provides a mechanical means for the removal of debris from inaccessible regions. However, the danger of injecting hydrogen peroxide into a closed body cavity is illustrated by the near-fatal outcome of the following case.

REPORT OF A CASE

An 8-month-old, healthy, infant boy weighing 10 kg was scheduled for excision of an anal fistula. Anesthesia was induced with halothane-nitrous oxide-oxygen via mask, and endotracheal intubation was performed uneventfully after the iv administration of atropine 0.1 mg and succinylcholine 10 mg. Anesthesia was maintained by halothane-N₂O-O₂ with assisted ventilation. After surgical plane of anesthesia was established, the patient was put into the lithotomy position, and examination by the surgeon showed an anal fistula opening and a palpable track. Vital signs showed blood pressure 100/70 mmHg and a heart rate 120 bpm. A catheter was inserted into the fistula, and 10 ml of 3% hydrogen peroxide was injected manually under pressure into the wound through the catheter. As the solution was being infused, vigorous bubbling was noted at the fistula opening, and very little irrigation solution was draining back out. About 5 min later, marked subcutaneous emphysema was noted in the scrotum and the entire perianal area. Also, there was a marked elevation of venous pressure with venous blood backflowing into the iv infusion tubing. A few seconds later a loud heart murmur was heard through the precordial stethoscope, and the heart rate decreased precipitously to 30 bpm, which did not respond to repeated doses of iv atropine and epinephrine. Arterial blood pressure became unobtainable, and patient became cyanotic. Anesthetic gases were quickly turned off, and ventilation was vigorously controlled with 100% oxygen, but the patient's condition remained the same. External cardiac massage was initiated and atropine 0.2 mg iv, epinephrine 0.2 mg intracardiac were given, followed by iv administration of sodium bicarbonate 20 mEq, calcium gluconate 500 mg, dexamethasone 10 mg, and hydrocortisone 100 mg over a 4-min period.

However, patient remained cyanotic with no palpable arterial blood pressure. A wide excision of the anal fistula was undertaken swiftly by the surgeon, and a large amount of air bubbles gushed out of the wound. Within seconds, the patient's heart rate went up to 180 bpm, with an arterial systolic blood pressure of 80 mmHg, and the skin color became pink. Mannitol 5 mg iv and sodium thiopental 50 mg iv were given for cerebral protection. Immediately after resuscitation, PaO₂ was 422 mmHg, PaCO₂ 24.5 mmHg, and pH_a 7.19. Sodium bicarbonate 20 mEq iv was given and a repeated arterial blood gas reported PaO₂ 450 mmHg, PaCO₂ 32 mmHg and pH_a 7.38. Serum electrolytes were within normal range. The patient resumed spontaneous breathing and starting to move all extremities. Central venous pressure, measured from the catheter inserted into the internal jugular vein, was 2 cmH₂O.

After the surgical wound was closed, the infant was transferred to the pediatric intensive care unit. One hour later the infant spiked a fever of 41° C, which returned to 37° C after 30 min surface cooling. At 3-h postsurgery, the trachea was extubated and the patient was alert, crying with purposeful movements. Follow-up evaluation of this patient showed no evidence of neurologic deficit.

DISCUSSION

Hydrogen peroxide solution is used in the cleansing of wound and removal of blood stains. Hydrogen peroxide is applied with the release of microbubbles of molecular oxygen, which have a slight germicidal effect and cause mechanical removal of tissue debris.¹ Olim and Ciuti in 1954 advocated its use as an effective irrigant to relieve colonic impaction in infants with meconium ileus. The proposed mechanism was that the nascent oxygen molecules liberated by hydroxygen peroxide on contact with tissue reduced surface tension between the meconium and intestinal mucosa, thereby freeing the meconium from the lumen of the intestine.² However, the administration of hydrogen peroxide into closed space or body cavities from which the release of oxygen has no egress is fraught with dangers. Near-fatal catastrophes were reported by different groups who used hydrogen peroxide as colonic irrigant in infants.^{3,4} Animal studies have shown that hydrogen peroxide is readily absorbed from body cavities such as intestine and peritonium, producing oxygen bubbles in the bloodstream and causing the physiologic derangement from gas embolism.⁴⁻⁶ In humans, intestinal absorption of hydrogen peroxide, causing gas embolism, has been demonstrated following intestinal irrigation.³⁻⁵ Bassan *et al.*⁷ reported a case of near-fatal air embolism in a

Received from the *Division of Anesthesiology, National Yang-Ming Medical College, Veterans General Hospital, Taipei, Taiwan, Republic of China 112, and the †Department of Anesthesiology, Harbor-UCLA Medical Center, Torrance, California 90509. Accepted for publication April 2, 1985.

Address reprint requests to Dr. Tsai: Department of Surgery, National Yang-Ming Medical College, Veterans General Hospital, Taipei, Taiwan ROC 112.

Key words: Anesthesia: pediatric. Embolism: Air, hydrogen peroxide.

54-year-old man undergoing irrigation of a herniorrhaphy wound with 3% hydrogen oxygen. Apparently irrigation under pressure of hydrogen peroxide solution into a semiclosed wound composed of bleeding friable tissue with small exit would lead to absorption of a significant amount of hydrogen peroxide and the nascent oxygen bubbles so produced into the venous system, which resulted in the near-fatal outcome. Fuson *et al.* reported that 1 ml of 3% hydrogen peroxide would release 10 ml of oxygen upon decomposition following contact with catalase in blood.⁸

The near-fatal outcome of our patient probably stems from the combination of late discovery of the gas embolism in a patient under general anesthesia and an initially unsuccessful cardiopulmonary resuscitation with a period of poor perfusion as reflected by the metabolic acidosis shown on arterial blood gas study. Nevertheless, our cases reaffirms the danger of using undiluted 3% peroxide solution for irrigation in a closed wound where systemic absorption of hydrogen peroxide and/or oxygen

bubble may lead to serious sequelae of gas embolism and it serves a warning to discourage the continuation of such application.

REFERENCES

1. Goodman LS, Gilman A: The pharmacological basis of therapeutics, fifth edition. New York, MacMillan, 1975, p 997
2. Olim CB, Ciuti A: Meconium ileus: A new method of relieving obstruction. *Ann Surg* 140:736-739, 1954
3. Davis RK, Brodeur AE: The danger of hydrogen peroxide as a colon irrigating solution. *J Pediatr Surg* 2:131-133, 1967
4. Shaw A, Cooperman A, Fusco J: Gas embolism produced by hydrogen peroxide. *N Engl J Med* 277:238-241, 1967
5. Yun DJ: Extrapulmonary oxygenation by giving hydrogen peroxide by enema. *Yonsei Med J* 2:125-131, 1969
6. Awad JA, Brassard A, Caron WM, Cadrin C: Intraoperative oxygenation with hydrogen peroxide. *Int Surg* 54:276, 1970
7. Bassan MM, Dudai M, Shalev O: Near fatal systemic oxygen embolism due to wound irrigation with hydrogen peroxide. *Postgrad Med J* 58:448-450, 1982
8. Fuson RL, Kylstra JA, Hochstein P, Saltzman HA: Intravenous hydrogen peroxide infusion as a means of extrapulmonary oxygenation. *Clin Res* 15:74, 1967

Anesthesiology
63:317-318, 1985

Naloxone Reversal of Postoperative Apnea in a Premature Infant

B. BEILIN, M.D.,* E. VATASHKY, M.D.,† H. B. ARONSON, M.B. CH.B., F.F.A.R.C.S.,‡
M. WEINSTOCK, M.Sc. Ph.D.§

In the perioperative period, preterm infants have a high incidence of complications, one of which is apnea.^{1,2} Apnea may be caused by ventilatory muscle fatigue,³ postoperative hypoxemia with abnormal ventilatory response to hypoxia,⁴ depressant effects of inhaled anesthetics on the chemoreceptor response to hypoxemia,⁵ and abnormal breathing control mechanisms in infants susceptible to sudden infant death syndrome (SIDS).

Infants with the apnea syndrome who have not had previous surgery have high endorphin levels in the

cerebrospinal fluid.⁷ Anesthetics also increase the release of endorphin.⁸ Thus, elevation of cerebral endorphins may play a role in perioperative apnea by preterm infants. On the basis of this hypothesis, we administered the opiate antagonist naloxone to an infant with postoperative apnea resulting in the restoration of normal respiration.

REPORT OF A CASE

A 4-week-old, 2.4-kg male infant, delivered by cesarean section at 35 weeks of gestational age, presented with vomiting and failure to thrive, caused by pyloric stenosis. The infant had been discharged from the nursery a week after delivery, and there was no preanesthetic history of apneic episodes or other respiratory problems. Blood electrolyte and glucose levels were normal, and Hb was 12.8 g/dL. No preanesthetic medication was given. Following breathing of 100% oxygen via mask, an awake tracheal intubation was performed. Anesthesia consisted of nitrous oxide, oxygen (40%), and halothane 1-1.5%. Ventilation was assisted with the use of the Jackson-Rees modification of the Mapleson D system. During the operation, which lasted 40 min, 60 ml of iv 4.3% glucose in 0.18% normal saline was administered. Heart rate ranged from 120 to 130 bpm. Arterial blood pressure (Doppler method) remained between 80/50 and 70/40 mmHg. Rectal temperature at the end of surgery was 36.1°C. Halothane was stopped 5 min before the termination of surgery,

* Instructor in Anaesthesiology.

† Lecturer in Anaesthesiology.

‡ Associate Professor of Anaesthesiology.

§ Professor of Pharmacology.

Received from the Departments of Anaesthesiology and Pharmacology, Hadassah University Hospital, Mount Scopus and Hebrew School of Medicine, Jerusalem, Israel. Accepted for publication April 2, 1985.

Address reprint requests to Dr. Beilin, Department of Anaesthesiology, Hadassah University Hospital, Mount Scopus, POB 24035, Jerusalem 91240, Israel.

Key words: Anesthesia; pediatrics. Antagonists, narcotic: naloxone. Ventilation: apnea.