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Continued catastrophic cardiovascular collapse following intraoperative hydrogen peroxide irrigation: time to reconsider its use!

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Letter to the Editor

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Hydrogen peroxide (H_2O_2) is commonly used for cleansing infected wounds in orthopedic and other surgeries. While often thought to be innocuous, the use of H_2O_2 has led to severe and fatal consequences [1]. Published literature is unclear about the volume of H_2O_2 that is safe for use. We present a case in which excessive volume of H_2O_2 was used for deep bilateral leg wound debridement leading to sudden cardiovascular collapse and cardiac arrest. We explored the recommended volume of H_2O_2 safe for use and lay down recommendations to avoid future mishaps. Written consent has been obtained from the patient for publication of this report.

We describe the management of a 37-year-old man who was allergic to naproxen and admitted for left knee septic arthritis and right calf cellulitis. He suffered from hypertension, uncontrolled type II diabetes mellitus, bilateral peroneal vein thrombosis (on treatment with enoxaparin) and acute kidney injury. He underwent left knee open arthrotomy, followed by second-look washout 4 days later, both under general anesthesia, uneventfully. Bilateral lower leg magnetic resonance imaging showed multiple septic emboli with deep pockets of pus in his right posterior calf and left gastrocnemius muscles.

He was scheduled for his 3rd surgery for exploration and drainage of abscesses in both lower limbs. A single-shot left femoral nerve block (15 ml of 0.5% ropivacaine) and a right popliteal block (20 ml of 0.5% ropivacaine) were performed before induction of general anesthesia. He received fentanyl (50 μg), lignocaine (10 mg), propofol (150 mg), and atracurium (30 mg), and airway was secured with an endotracheal tube. He had also received these drugs in the previous two surgeries. He was placed in the right lateral decubitus position for surgery. Anesthesia was maintained with sevoflurane and intermittent atracurium and morphine. End-tidal carbon dioxide ($EtCO_2$) was maintained at 36–42 mmHg. He remained hemodynamically stable throughout surgery. Towards the final stages of surgery, wounds on both lower limbs were irrigated with mixed H_2O_2 (3% w/w, PharmaKoe, ICM Pharma, Singapore) and normal saline. A total of 800 ml of 3% H_2O_2 was used considering extensive bilateral deep wounds. While wounds were irrigated, the patient showed signs of breathing, and atracurium (10 mg) was administered. A few minutes later, a sudden drop in $EtCO_2$ (7 mmHg) was noted. Breathing circuits and carbon dioxide sampling line were checked. The patient was hand ventilated with 100% oxygen.

Saturation remained > 97%; however, blood pressure dropped to 81/22 mmHg, and bradycardia developed (37 beats/min). Two separate doses of atropine 0.6 mg were administered without improvement. The carotid pulse was absent. Pulseless electrical activity was declared, and the patient was turned supine for external chest compressions. He received three boluses of 1 mg adrenaline before the return of spontaneous circulation.

The total resuscitation time was 5 min. Post-resuscitation blood pressure was 128/108 mmHg, with a heart rate of 154 beats/min. The left radial artery was cannulated, and a blood sample for arterial blood gas revealed respiratory acidosis (pH: 7.189, pCO_2: 65.9 mmHg). A central venous line was inserted, and an infusion of noradrenaline (0.2 μg/kg/min) was started. The patient was transferred to the intensive care unit. There was no evidence of pulmonary embolism on computed tomography pulmonary angiography. Postoperative troponin (33.9 pg/ml), and electrocardiogram (ECG) were unremarkable. Two-dimensional echocardiography revealed no abnormalities. Wound cultures from both calves grew methicillin-susceptible Staphylococcus aureus; however, blood cultures were negative. The patient was extubated the next day and transferred to the general ward. Subsequently, the patient underwent wound debridement thrice without H_2O_2 under general anesthesia uneventfully.

The cause of cardiovascular collapse in this patient may include anaphylaxis due to atracurium, myocardial infarction, septic shock, and pulmonary embolism. However, anaphylaxis due to atracurium was unlikely in the absence of bronchospasm and skin rashes. Sepsis was ruled out because there was no rise in temperature and the blood culture was negative. Myocardial infarction was ruled out because troponin was within the expected range and ECG remained unremarkable. Cardiovascular collapse in the true sense coincided with washing of wounds with H_2O_2.

The exact mechanism of cardiovascular collapse is unknown, but embolic phenomenon is widely accepted. Urban et al. [2] recommended 3% H_2O_2 solution as a safe and effective irrigation solution but did not specify the volume. In published literature, the concentration and volume of H_2O_2 are 1–3% and up to 300 ml, respectively [3]. At standard temperature and pressure, 1 ml of 3% H_2O_2 elaborates approximately 10 ml of oxygen [3]. H_2O_2 in closed cavities under pressure is considered to pose a higher risk of oxygen embolus [4]. In our case, 800 ml of 3% H_2O_2, certainly excessive, was used to clean bilateral large deep wounds, which probably released 8 L of oxygen. Some oxygen entered into the closed spaces, which had no egress, thus entering the blood vessels through the perforation of a plexus vein. The injection of bubbles into the plexus vein led to gas emboli entering the right heart, causing a decrease in the cardiac output, resulting in catastrophic cardiovascular collapse [3].

Lu and Hansen [5] suggested that the use of H_2O_2 in orthopedic surgery requires more large-scale clinical studies to determine its effectiveness and safety as an adjunct antiseptic. The UK Medicines and Healthcare Regulatory Agency [4] published a safety alert advising not to use H_2O_2 in closed body cavities and deep wounds. We performed internet searches on the maximum recommended doses of H_2O_2, but no conclusive results emerged. We contacted the local supplier PharmaKoe (Singapore) and Health Sciences Authority (Singapore's regulatory body for healthcare products); however, they had no firm information about recommended doses (email communications).

In conclusion, H_2O_2 is considered a safe agent for wound debridement, however, cases of catastrophic cardiovascular collapse have been reported, and its utility has been questioned [1]. Currently there is no clear recommendation for either H_2O_2 concentration or volume, and a consensus guidance is required. Until the availability of clear recommendations, greater vigilance is necessary when H_2O_2 irrigation is used.

Conflicts of Interest

No potential conflict of interest relevant to this article was reported.

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