

Sevoflurane addiction due to workplace exposure

A case report and literature review

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Abstract

Rationale: Anesthesiologists have a well-known increased risk of substance abuse. High-concentration of inhalation anesthetics in exhaled air of operating room personnel is detected. Such secondhand exposure produces neurobiological sensitization to the reinforcing effects of inhalation anesthetics.

Patient concerns: An addictive young male anesthesiologist who was long-term abuse with sevoflurane after 4 years occupational exposure. A 28-year-old anesthesiologist on duty was found deeply sleep in the locker room and covered his nose with Gauze with high-concentration of sevoflurane. He was found addiction to sevoflurane second time. Several life-threatening incidents occurred including severe aspiration pneumonia. No other addiction was found in his history before he became severely dependent on sevoflurane.

Diagnoses: A visual analog scale was employed to assess the severity of craving for sevoflurane and the Benzodiazepine Withdrawal Symptom Scale (BWSQ2)-scale was used to assess sevoflurane withdrawal syndrome (WS).

Interventions: First time an opened original sevoflurane container filled with water instead of sevoflurane was handed out for a minute in order to elicit craving and withdrawal symptom in five therapeutic single-sessions. Second time an opened original sevoflurane container filled with sevoflurane instead of water was used as his powerful cur-stimulus and also was handed out for a minute.

Outcomes: After professional therapy and continuous surveillance he was rehabilitation and back to work. However, after three weeks he became addiction to sevoflurane again. He showed very sensitive to sevoflurane and switched to other career.

Lessons: This case emphasizes that secondhand exposure to inhalation anesthetics may be dangerous and increase the life-threatening professional risk to anesthesiologists, although identification of the responsible factor remains difficult. However, the safety of operating room staff should be aroused wide-spread social concern.

Abbreviations: BWSQ2 = benzodiazepine withdrawal symptom, GABA = γ -aminobutyric acid, WS = withdrawal syndrome.

Keywords: addiction, anesthesiologists, health personnel, secondhand exposure, sevoflurane

1. Introduction

Sevoflurane, the most commonly used inhalation anesthetic worldwide, is detected at high concentrations in the operating room.^[1,2] Previous research showed that operating room personnel's sevoflurane concentrations are higher than those of controls in exhaled air after duty.^[1] Exposure to secondhand volatile anesthetics leading to potential health hazards causes

widespread social concern.^[3,4] Animal evidence *in vivo* and *in vitro* has indicated that sevoflurane induces neurodegeneration and apoptosis in dose- and time-dependent models.^[5-9] However, it remains unknown whether chronic exposure to inhalation anesthetics in the operating room poses potential health hazards to anesthesiologists.

Researchers have indicated that compared to physicians in other specialties, anesthesiologists are more likely to abuse drugs.^[10,11] One of the most common reasons is easy access to drugs with the potential for abuse. Additionally, chronic exposure to low doses of aerosolized opioids and anesthetics in the operating room is another reason for inflated rates of addiction among anesthesiologists.^[12,13] Previous studies have proved that although sensitization is unintended, there is an increased risk of developing substance dependence due to work-related secondhand exposure.^[12,13] Workplace exposure can increase the risk of addiction, especially among anesthesiologists with genetic vulnerability to anesthetics of abuse. However, it remains unknown whether high concentrations of inhaled anesthetics detected in operating room air could lead to drug abuse.

This article presents a case of an addicted young male anesthesiologist who was abusing sevoflurane for an extended period of time after 4 years of occupational exposure. He was found to be addicted to sevoflurane a second time. No other addiction was found in his history before he became severely dependent on sevoflurane.

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2. Case report

A 28-year-old anesthesiologist on duty was found deeply asleep in the locker room and had covered his nose with gauze containing a high concentration of sevoflurane. The sevoflurane container was found beside him. He could not be awakened and was transferred to bed by a colleague. He was found to be addicted to sevoflurane a second time. His superiors mandated his admission for inpatient detoxification from sevoflurane. He admitted that self-detoxification had repeatedly failed due to his intense craving. His most powerful cues were secondhand exposure to sevoflurane in ambient air discharge from patients and anesthesia breathing circuits and easy access to the sevoflurane container.

With no prior experience with addictive substances including alcohol and nicotine, the patient had tried inhaling anesthetic sevoflurane 1 year previously. He referred to novelty seeking and treating insomnia as his main motivations. Sevoflurane in a dose range of 3 to 5 mL via sniffing with gauze resulted in a few minutes of cloudy euphoric relaxation. He enjoyed the effect of sevoflurane-induced euphoria. He eventually increased the dose from 6 to 8 mL to induce sleep after work. He had never experienced side effects and severe respiratory depression and gradually increased the doses and frequency. He developed severe aspiration pneumonia and was admitted to the hospital for several days of treatment because of increased doses of sevoflurane and a full stomach after dinner. He was first exposed as misusing this inhalant because he was found deeply asleep on a portable operating table with his nose covered with gauze. He admitted to sevoflurane misuse and claimed a sleep disorder as an excuse. After 4 months of standardized treatment, he returned to work. However, after 3 weeks, he took sevoflurane again because he could not stand secondhand sevoflurane from patients with general anesthesia and ambient air.

The patient was distracted throughout the workday and often left his post for 1 or 2 hours with varying excuses. He often fell down while under the influence of sevoflurane but could not remember how the falls occurred. There were always fresh hematomas on his face from falls and his eyes were bloodshot.

Upon his first hospital admission, the patient was in a severely depressed and anxious state. Physical examination revealed nothing unusual except for older fall-related injuries and bloodshot eyes. He admitted to sevoflurane misuse and claimed a sleep disorder as an excuse for his addiction. After being accused of abuse a second time, he remained silent for 1 week, and then again confessed to sevoflurane abuse.

Figure 1 presents the first course of the patient's craving for sevoflurane and withdrawal symptoms. A visual analog scale (0=none and 10=most intense experienced) was employed to assess the severity of his craving for sevoflurane, and the benzodiazepine withdrawal symptom (BWSQ2) scale^[14] (0=none and 40=maximum score) was used to assess sevoflurane withdrawal syndrome (WS). Figures 1A and D are from the period immediately before treatment and were collected retrospectively. The entire period of inpatient treatment is presented in Figures 1B, C, E, and F. After cessation of sevoflurane abuse, the patient's craving and withdrawal symptoms were severe on the first day and lasted 5 to 7 days (Figs. 1A and D). During the detoxification treatment period, an open original sevoflurane container filled with water instead of sevoflurane because of sevoflurane's volatilization characteristics was given to him for 1 minute in order to elicit his craving and withdrawal symptoms in 5 single therapeutic sessions (Figs. 1B,

C, E, and F). After the fourth repeated cue exposure, his craving for sevoflurane became desensitized (Fig. 1C). However, there was no effect on his withdrawal symptoms after repeated cue exposure (Fig. 1F).

Figure 2 presents the second course of the patient's craving for sevoflurane and withdrawal symptoms. Figures 2A and D were collected retrospectively because the patient at first refused to communicate. After cessation of sevoflurane abuse, his craving and withdrawal symptoms were severe on the first day and lasted 7 to 9 days (Figs. 2A and D). Compared to the first time, there were no significant differences in the patient's craving for sevoflurane and accompanying withdrawal signs (Figs. 2B, C, E, and F). In order to assess whether he was sensitive to sevoflurane, at the end of treatment an open original sevoflurane container filled with sevoflurane instead of water was given to the patient for 1 minute to assess his cue stimulus. Compared to water in the container, sevoflurane increased his craving and withdrawal symptom (very sensitive to smell) (Figs. 2C and F). When repeated the next day using water as his powerful cue stimulus, there was no response to the craving and withdrawal symptoms.

After 4 months of rehabilitation, the patient was persuaded to pursue another medical career outside of anesthesiology because of his sensitivity to sevoflurane.

Ethical approval for this study was approved by the Ethical Committee of Huazhong University of Science and Technology.

3. Discussion

In this case, we first presented an anesthesiologist who abused sevoflurane after 4 years of occupational exposure, although identification of the responsible factors remains difficult. However, the safety of operating room staff should cause widespread social concern. Workplace exposure can increase the risk of addiction, especially in anesthesiologists with genetic vulnerability to anesthetics of abuse. There is precedent evidence that workplace exposure in bartenders and wait staff increases the risk of addiction to alcohol.^[10] In this case, the patient was very sensitive to sevoflurane the second time (Fig. 2C). This may be why he again became addicted to sevoflurane only 3 weeks after returning to work. However, it remains unknown whether workplace exposure led to his addiction to sevoflurane or addiction led to his sensitivity to secondhand sevoflurane.

There are no standard criteria for determining sevoflurane withdrawal symptoms. We selected the BWSQ2 scale because both sevoflurane and benzodiazepines cause addiction primarily through the activation of the γ -aminobutyric acid (GABA)_A receptor.^[6,15–17] A previous report also used the BWSQ2 scale to assess the withdrawal symptoms for propofol dependence, which activates the GABA_A receptor.^[18] In this case, there was a markedly shorter duration in the WS than the craving (Figs. 1 and 2).

During the detoxification treatment period, the patient's powerful cue was stimulated by an open original sevoflurane container filled with water instead of sevoflurane because of sevoflurane's volatilization characteristics. Water was effective to elicit the patient's craving for sevoflurane in the first 3 therapeutic sessions (Figs. 1 and 2). However, during the second detoxification period, sevoflurane instead of water increased his craving and withdrawal symptoms (Fig. 2, very sensitive to smell). He was very sensitive to sevoflurane when he held it for 1 minute. This cue implies that the patient may be at increased risk for repeated abuse of sevoflurane and should not be allowed to return to his usual work.

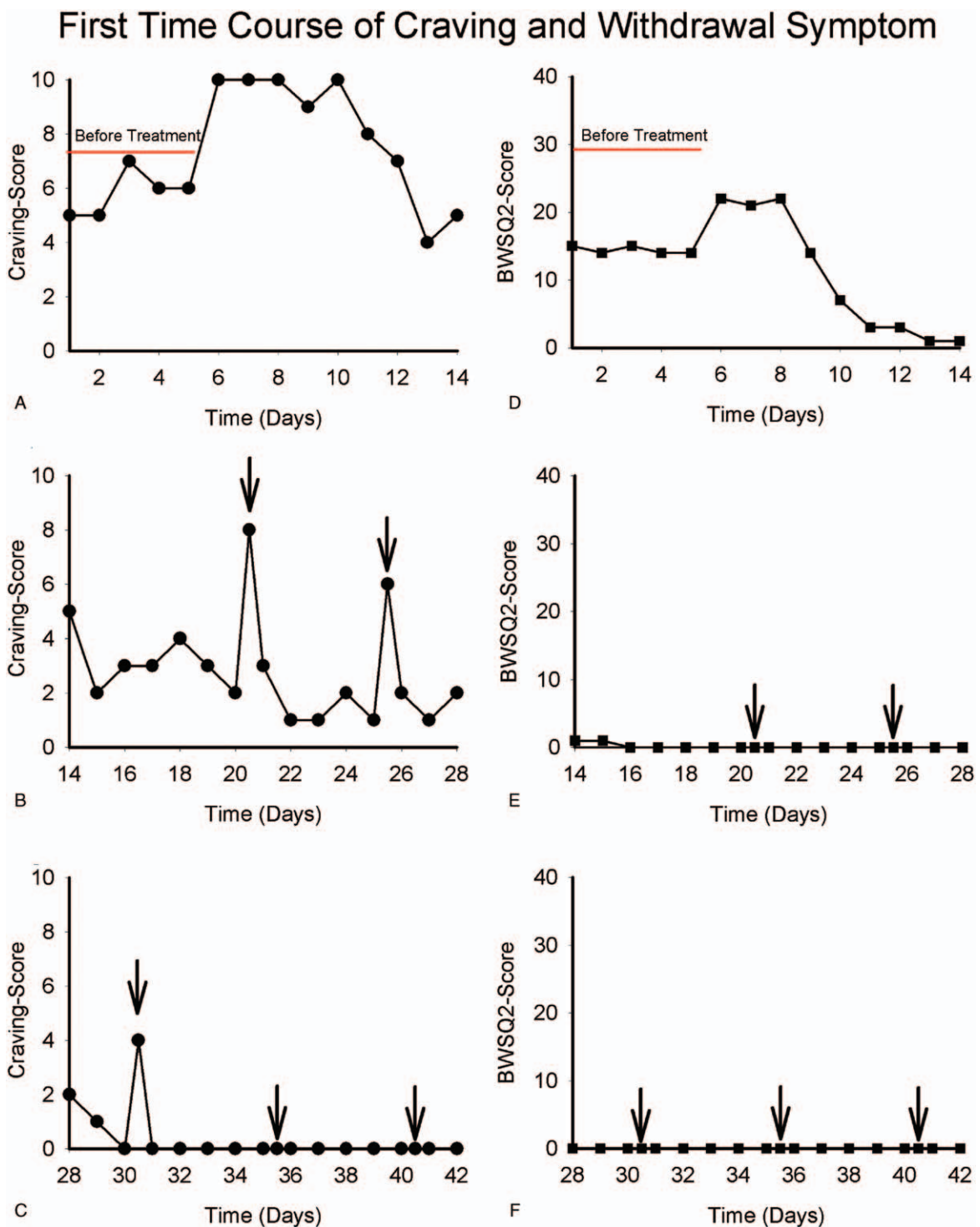


Figure 1. First course of craving (A–C) and withdrawal syndrome (D–F) before and after treatment. A and D were collected retrospectively before admission. B, C, E, and F show the entire subsequent inpatient detoxification treatment. A visual analog scale and the BWSQ2 scale were employed to assess the severity of craving for sevoflurane and withdrawal syndrome, respectively. The black arrows represent exposures to an open sevoflurane container with water during inpatient detoxification. The same time frames are shown in A–C and D–F. BWSQ2=benzodiazepine withdrawal symptom.

Chronic exposure to secondhand anesthetics discharged from patients and anesthesia breathing circuits could endanger operating room staff. First, there is a positive relationship between the rate of birth defects and occupational exposure to anesthetics. Previous studies have established that the concentrations of exhaled sevoflurane for operating room staff are high

compared to other department staff members.^[3] Accumulated evidence indicates that sevoflurane induces neurodegeneration and apoptosis in vitro and vivo.^[6–8] Neurons in the developing brain are specifically vulnerable to anesthetics, although the concentration of sevoflurane is 20-fold less than the recommended threshold values that induce apoptosis.^[1,19,20] Second,

Second Time Course of Craving and Withdrawal Symptom

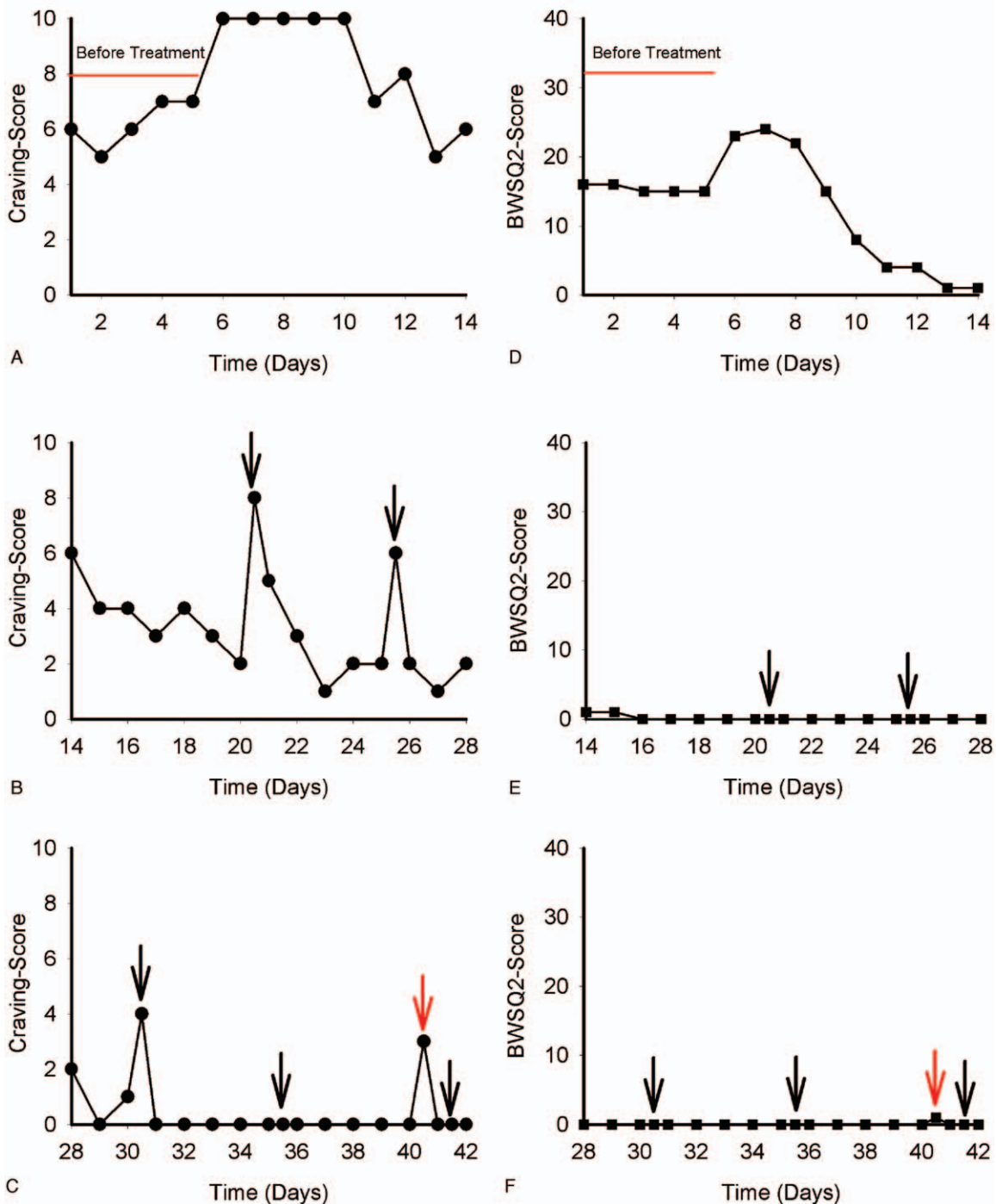


Figure 2. Second course of craving (A–C) and withdrawal syndrome (D–F) before and after treatment. A and D were collected retrospectively before admission. B, C, E, and F show the entire subsequent inpatient detoxification treatment. A visual analog scale and the BWSQ2 scale were employed to assess the severity of craving for sevoflurane and withdrawal syndrome, respectively. The black arrows represent exposures to an open sevoflurane container with water during inpatient detoxification. The red arrow represents exposures to an open sevoflurane container with sevoflurane during inpatient detoxification. The same time frames are shown in A–C and D–F. BWSQ2=benzodiazepine withdrawal symptom.

there is a significant relationship between the rate of spontaneous abortion and occupational exposure to anesthetics.^[3] Third, for anesthesiologists, chronic workplace exposures to low doses of anesthetics throughout their careers cause considerable time-dependent burdens. We investigated whether there was anesthetic

gas exhaust treatment systems in the operating rooms of 245 hospitals in China: 24 (9.8%) hospitals did not have these systems, 50 (20.4%) hospitals had them, and 171 (69.8%) hospitals had them only in some operating rooms. According to our survey, approximately 80% of hospitals did not have gas

exhaust treatment systems or discharged to open air in a safe area. Effluent gas with a high concentration of anesthetics was directly discharged without any treatment into the operating room, leading staff to experience discomfort, dizziness, headache, and fatigue after they spent a typical workday in the operating room. Effective ventilating systems should be installed in all operating rooms and the quality of the surgical setting may need to be addressed.

Author contributions

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