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Preventable in-body hydrogen explosions from high-concentration H_2 inhalers in Japan—Switch to safe, low-concentration hydrogen therapy

Yusuke Ichikawa[1], Bunpei Sato[1], Yoshiyasu Takefuji[2,3], and Fumitake Satoh[1]

Abstract

Background: With the growing recognition of the medical applications of hydrogen, hydrogen gas inhalers are increasingly used in clinics and other healthcare settings. However, hydrogen is highly explosive, and numerous explosion incidents involving these inhalers have been reported.

Objectives: This study evaluates the safety risks of high-concentration hydrogen inhalers (67%–99.99% v/v H_2) following multiple device explosions and a documented pulmonary explosion case, and to determine an optimal concentration balancing safety and efficacy.

Methods: We analyzed device explosion incidents recorded by the Consumer Affairs Agency of Japan and an in-body hydrogen explosion case reported in a 2024 scientific paper, and subsequently discussed the factors contributing to these accidents based on the explosive properties of hydrogen gas.

Results: High-concentration inhalers (>10% v/v H_2) pose a substantial explosion risk, as confirmed by multiple device failures reported by Japan's Consumer Affairs Agency and a 2024 in-vivo pulmonary explosion case. Limiting hydrogen to ≤10% v/v maintains efficacy for intracellular hydroxyl radical scavenging while staying below the lower explosive limit.

Conclusion: Two critical preventable hazards exist with high-concentration hydrogen therapy: external device explosion and internal airway detonation. Immediate transition to low-concentration (≤10% v/v H_2) inhalers is strongly recommended, as they provide effective concentration while eliminating life-threatening risks, ensuring patient safety without compromising clinical outcomes.

Keywords

hydrogen gas inhalation, hydrogen explosion, low-concentration hydrogen therapy, hydroxyl radical scavenging, patient safety

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Introduction

Hydrogen concentration in hydrogen gas inhalers as an indicator for assessing explosion risk

For the purposes of this paper, we distinguish two categories of incidents: preventable versus non-preventable. This paper spotlights a globally alarming surge of preventable clinical accidents caused by high-concentration hydrogen inhalers (67–99.99% v/v H_2), all driven by a dangerous underestimation of hydrogen's explosion risk.

[1]Research and Development Department, MiZ Company Limited, Kamakura, Japan
[2]Faculty of Data Science, Musashino University, Tokyo, Japan
[3]Keio University, Tokyo, Japan

Corresponding author:
Yusuke Ichikawa, Research and Development Department, MiZ Company Limited, 2-19-15 Ofuna, Kamakura, Kanagawa 247-0056, Japan.
Email: y_ichikawa@e-miz.co.jp

Hydroxyl radicals, which are constantly generated in vivo, are the most reactive of all reactive oxygen species.[1–3] They indiscriminately react with proteins, nucleic acids, and lipids that constitute cells, leading to chronic inflammation, genetic mutations, and aging.[3] Hydrogen directly reacts with hydroxyl radicals and neutralizes their harmful effects by converting them into water molecules.[4] Due to this property, hydrogen gas inhalation therapy is being increasingly adopted in Japan at clinics and osteopathic hospitals to control and improve diseases related to chronic inflammation.

However, hydrogen is a flammable and explosive gas, and reports have warned about the risk of explosion accidents involving high-concentration hydrogen gas inhalers.[5,6] In particular, explosions caused by such inhalers are extremely hazardous because they involve instantaneous detonation and rupture triggered by spontaneous ignition sources such as static electricity.[7,8] This makes users highly susceptible to direct harm.[7] Currently, hydrogen gas inhalers that deliver 67% v/v or nearly pure hydrogen (≈99.99% v/v) generated by water electrolysis are available on the market.[5,6]

Hydrogen concentration is a fundamental indicator for assessing explosion risk. Although the explosive concentration of hydrogen is generally considered to be 4% v/v or higher, we found that concentrations at or below 10% v/v do not lead to an explosion.[5,6] Consequently, 10% represents the critical threshold, and concentrations below 10% v/v pose no risk of explosion.[5,6] Although the upper explosive limit of hydrogen is 75% v/v, even hydrogen gas at concentrations above 75% v/v will inevitably create regions within the surrounding air where it is diluted to explosive concentrations of 10–75% v/v.[6] In other words, inhalation devices that generate high-concentration hydrogen, such as 67% v/v or nearly 100% v/v, inherently carry a risk of hydrogen explosion (Figure 1). Hydrogen exhibits explosiveness at concentrations of 10% v/v or higher, regardless of the total amount. Furthermore, at concentrations above the explosive limit, the larger the amount of hydrogen present, the greater the scale of the explosion. However, some manufacturers of high-concentration hydrogen gas inhalers deliberately misinterpret the original significance of "hydrogen concentration" falsely asserting that "The higher the hydrogen concentration, the better" or "The greater the amount of hydrogen, the more beneficial". Since hydrogen inherently possesses explosive properties, any inhaler handling hydrogen at concentrations of 10% v/v or higher cannot eliminate the risk of explosion. In fact, the Japanese Consumer Affairs Agency's accident databank has received numerous reports of explosions involving high-concentration hydrogen gas inhalers themselves.

In Japan, since the widespread introduction of high-concentration hydrogen gas inhalers after 2024, a number of explosion incidents have been reported. These include not only explosions of the inhaler units themselves, which generate high concentrations of hydrogen gas, but also in-body hydrogen explosions occurring in users during inhalation, resulting in severe injuries such as complex facial fractures and pulmonary burns.

This study investigates documented cases of in-body hydrogen explosions associated with the use of high-concentration hydrogen gas inhalers and raises concerns about their potential explosion hazards. Furthermore, the mechanical characteristics of low-concentration hydrogen gas inhalers are described, and the therapeutic efficacy expected from low-concentration hydrogen inhalation is discussed.

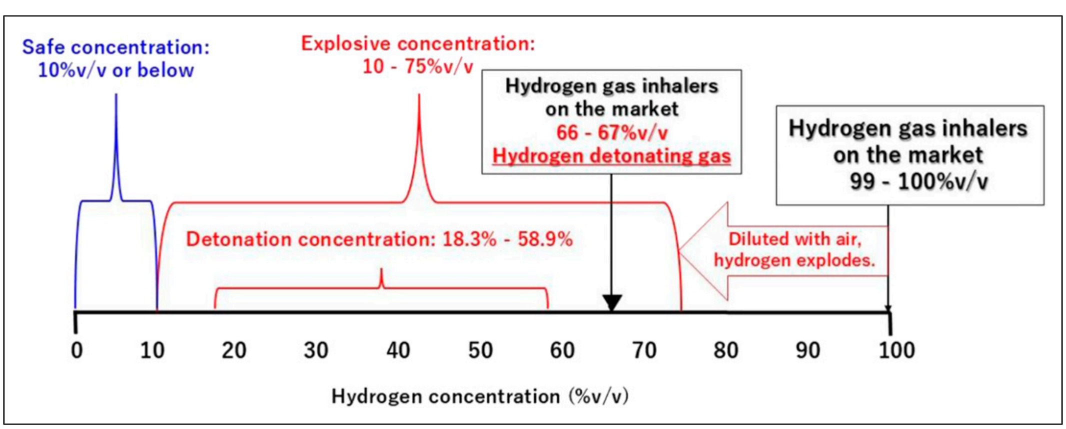

Figure 1. Hydrogen concentrations and the explosive properties of hydrogen. The explosive concentration range of hydrogen is 10% v/v to 75% v/v. Even hydrogen gas inhalers that generate hydrogen with a concentration in the range of 99% to 100%, which is higher than the upper explosive limit, pose a risk of explosion because hydrogen becomes diluted with the surrounding air to reach an explosive concentration. A mixed gas consisting of hydrogen and oxygen with a hydrogen concentration of 66% to 67% is called hydrogen detonating gas, and it may explode with an extremely violent explosive sound.

Methods

To investigate explosion incidents involving hydrogen gas inhalers, we conducted a comprehensive search using the Accident Information Databank maintained by the Consumer Affairs Agency of Japan (https://www.jikojoho.caa.go.jp/ai-national/), as well as an internet-based literature review of academic journals reporting similar cases.

Results

Accident cases reported to the Japanese consumer affairs agency's accident data bank

The following are excerpts from 12 cases of hydrogen explosion accidents involving hydrogen gas inhalers reported to the Japanese Consumer Affairs Agency's Accident Data Bank (https://www.jikojoho.caa.go.jp/ai-national/), focusing on those that resulted in human injuries (Figure 2).

Accident case 1: Complex facial fracture

Date of accident: February 2025. Summary of accident: A mother suffered a complex facial fracture due to a hydrogen explosion while undergoing hydrogen inhalation therapy at an esthetic salon.

Accident case 2: Rupture of internal organs

Date of accident: October 2024. Summary of accident: While a father was using a hydrogen gas inhaler at home for cancer treatment, he heard a loud bang and was suddenly covered in blood. His internal organs ruptured, and he is currently in the ICU.

Accident case 3: Massive bleeding

Date of accident: September 2024. Summary of accident: A father suffered massive bleeding while using a hydrogen inhaler at home and was rushed to the emergency room. He is currently in the ICU due to a perforation in his bronchus.

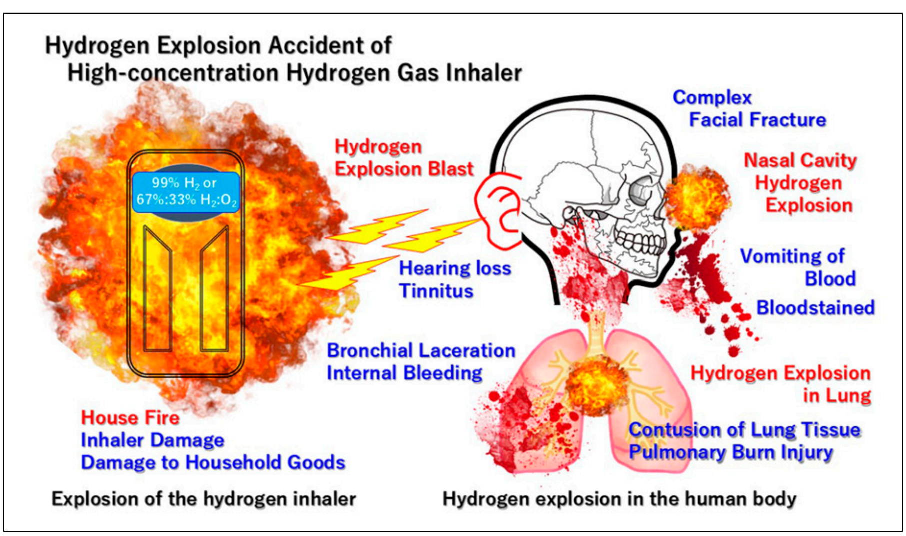

Figure 2. Reports of hydrogen explosion accidents due to the use of high-concentration hydrogen gas inhalers accidents involving in-body hydrogen explosions have been increasingly reported, caused by the inhalation of high-concentration hydrogen reaching explosive levels in the lungs, oral cavity, and nasal passages. High-concentration hydrogen gas inhalers pose a risk not only of explosion of the device itself but also of explosions occurring within the human body. Regardless of the extent of explosion-proof mechanisms installed in high-concentration hydrogen inhalers, inhaling hydrogen at high concentrations cannot prevent explosions inside the body. The reported accidents were extracted from the consumer affairs agency accident database and from reference 9.

Accident case 4: Fracture in the face

Date of accident: January 2024. Accident summary: While using a highly concentrated hydrogen and oxygen inhaler at the entrance of her home, the device inserted into her nose exploded. The victim suffered a facial fracture and was hospitalized.

Accident case 5: Tinnitus

Date of accident: February 2016. Summary of accident: After using a hydrogen/oxygen mixed gas inhaler, the user lifted the device, causing the lid to fly off with an explosive sound, resulting in tinnitus symptoms.

Accident case 6: Hearing loss

Date of accident: January 2015. Summary of accident: At the end of the previous year, a hydrogen inhaler was purchased through an acquaintance. It exploded twice, leading to hearing loss.

Discussion

Hydrogen explosion in the human body and consideration of accident causes

Astonishingly, in 2024, the accident databank of the Consumer Affairs Agency (Japan) reported multiple severe accidents involving hydrogen explosions occurring inside the bodies of users of high-concentration hydrogen gas inhalers. These incidents resulted in serious injuries such as complex facial fractures, ruptured internal organs (lungs), bronchial lacerations, and hematemesis (Figure 2). Despite some cases where patients suffering from hematemesis and lung rupture were transported to intensive care units (ICUs), the manufacturer of the inhaler responsible for these accidents has continued to conceal the incidents and has not taken any action, such as issuing a recall. As a result, clinics and osteopathic facilities using high-concentration hydrogen gas inhalers remain unaware of the dangers and continue to use inhalers that pose a risk of explosions inside the human body.

In the same year, an even more horrific case of an internal hydrogen explosion was reported in a scientific journal.[9] The Emergency and Critical Care Medicine at Ebina General Hospital (Kanagawa, Japan) documented an incident in which a breast cancer patient, while undergoing a combination of electromagnetic wave irradiation using a heat therapy machine and hydrogen gas inhalation at home, she suddenly experienced an explosion sound in her chest and a burning smell, followed by hemoptysis.[9] The patient was transported to an emergency hospital, where a CT scan revealed lung contusions centered around the alveoli, leading to a diagnosis of inhalation-induced combustion lung injury.[9]

Previously, explosion accidents involving high-concentration hydrogen gas inhalers have only occurred in home settings. However, in February 2025, the Japan Consumer Affairs Agency's Accident Data Bank reported that a customer undergoing hydrogen inhalation at an esthetic salon suffered a complex facial fracture due to a hydrogen explosion and was taken to the hospital. In the future, the number of explosion accidents at clinics and chiropractic or osteopathic clinics is expected to increase.

We discuss these incidents. Since an explosion cannot occur when the hydrogen concentration is less than 10% v/v, it is suggested that the hydrogen concentration in the lungs may have reached an explosive level due to the inhalation of high-concentration hydrogen gas. Normally, it is inconceivable for an ignition source to be generated within the human body. However, for example, static electricity may be generated near the attachment point of a nasal cannula, close to the nose, where hydrogen is released. An explosion triggered by this static electricity could have propagated to the interior of the nasal cavity or lungs, where the hydrogen concentration exceeded 10% v/v, reaching an explosive level.

In the case of the Ebina General Hospital accident, it is presumed that the use of a high-concentration hydrogen gas inhaler caused the electromagnetic energy from the heat therapy machine to ignite a hydrogen explosion inside the lungs when the hydrogen concentration reached an explosive level.[9]

In an animal experiment, it was reported that when pigs inhaled hydrogen gas using a high-concentration hydrogen gas inhaler, which generates 100% hydrogen at a flow rate of 250 mL/min, the hydrogen concentration in the exhaled air reached a calculated value of 8.3% v/v and a measured value of 5–10% v/v.[10] Although this result was obtained in animal experiments, the authors used pigs instead of small animals such as rats or mice, stating that pigs were chosen because their anatomical and physiological structures are similar to those of humans.[10] Therefore, this report suggests that under certain conditions—such as when the inhaler user has a small lung capacity or uses a device that generates a larger amount of hydrogen—the hydrogen concentration in exhaled air is likely to exceed the explosive limit of 10% (v/v) in humans when using a high-concentration hydrogen gas inhaler.

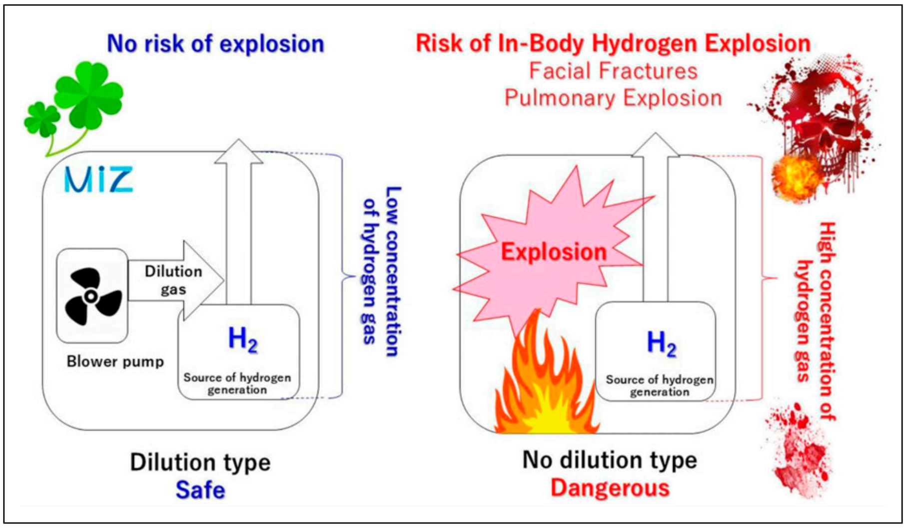

Figure 3. Low-concentration hydrogen gas inhalers without explosion risk versus high-concentration hydrogen gas inhalers with explosion risk. Inhalers that generate 100% v/v hydrogen or a hydrogen–oxygen mixture (H_2:O_2 = 67% v/v: 33% v/v) pose a high risk of explosion, not only within the device but also potentially within the human body (Right figure). In contrast, low-concentration hydrogen gas inhalers dilute hydrogen to below explosive levels (10% v/v) within the device, eliminating the risk of both inhaler-related explosions and in vivo hydrogen explosions (Left figure). A representative product of safe, low-concentration hydrogen gas inhalers is "Jobs-α+" (approx. 7% v/v) and "Jobs-α+Lite" (approx. 3.6% v/v) manufactured by MiZ company limited (Kanagawa Pref., Japan). MiZ company limited has secured patents in 10 countries, including Japan, for its technology to dilute hydrogen to safe concentrations.

That is to say, high-concentration hydrogen gas inhalers pose a risk of explosion not only within the inhaler itself but also inside the human body. Even if explosion-proof measures are implemented in the inhaler itself, as long as high-concentration hydrogen gas continues to be inhaled, explosions inside the nasal cavity, lungs, and their surrounding areas cannot be completely prevented. Therefore, as long as high-concentration hydrogen gas, such as 67% v/v or 99.99 % v/v, which exceeds the lower explosion limit of 10% v/v, is handled, explosions causing human casualties will inevitably continue to increase.

Recommendations for low-concentration hydrogen gas inhalers

Even inhalation of low-concentration hydrogen, such as 4% v/v, has been shown in animal experiments to deliver a sufficient amount of hydrogen throughout the body.[11] Clinical trials and research studies have reported improvements in conditions such as mild cognitive impairment, myalgic encephalomyelitis/chronic fatigue syndrome, and sudden hearing loss, even with low-concentration hydrogen inhalation.[12–14] Furthermore, even inhalation of hydrogen at only 2% v/v during cardiopulmonary resuscitation after out-of-hospital cardiac arrest has been reported to reduce patient mortality and achieve successful social reintegration without sequelae.[15] Therefore, there is no need to inhale high concentrations of hydrogen at the risk of explosion; instead, prolonged inhalation of safe, low-concentration hydrogen can be expected to provide sufficient medical benefits. In other words, for medical applications of hydrogen, as clinical benefits can be expected as long as the hydrogen concentration reaches approximately 2 vol% or higher, the concentration produced by a hydrogen inhaler should be considered not as an indicator of therapeutic efficacy, but rather as a safety parameter to assess the potential risk of hydrogen explosion.

To avoid hydrogen explosion accidents, when choosing a hydrogen gas inhaler for therapeutic or other purposes, it is advisable to select a device that maintains a hydrogen concentration below the explosive threshold (10% v/v).[5,6] Most commercially available hydrogen gas inhalers deliver hydrogen or a hydrogen–oxygen mixed gas generated by water electrolysis directly to the user, which poses a high risk of hydrogen explosion.[5,6] In contrast, some inhalers on the market are designed to immediately dilute high-concentration hydrogen, generated near the source or in its vicinity, to below explosive levels (i.e., ≤10% v/v) before inhalation.[5,6] Selecting such devices is essential not only to prevent explosion accidents associated with hydrogen gas inhalers but also to minimize the risk of hydrogen explosions within the human body (Figure 3).

An important consideration for hydrogen-mediated disease mitigation is that hydroxyl radicals are continuously generated as long as we breathe. Therefore, delivering hydrogen throughout the body does not require high concentrations; rather, it is essential to maintain a continuous supply through prolonged inhalation, even at low concentrations.

Conclusions

The accidents reported in the accident databank of the Consumer Affairs Agency are likely caused by explosive concentrations of hydrogen in the lungs or exhaled breath due to the use of high-concentration hydrogen gas inhalers that generate hydrogen at explosive levels, such as 67% v/v or 100 (≈99.99)% v/v. If the hydrogen concentration inside the human body, such as in the lungs, reaches the explosive threshold of 10% v/v, an external ignition source, such as static electricity, could ignite the hydrogen, leading to an internal hydrogen explosion within the lungs and potentially causing severe injuries, including lung tissue damage. Electromagnetic waves from thermotherapy devices could also serve as an ignition source for hydrogen explosions within the lungs.

In other words, high-concentration hydrogen gas inhalers pose the risk of explosion not only within the inhaler itself but also inside the human body. Even if the inhaler is equipped with explosion-proof mechanisms such as a backfire valve, it cannot prevent explosions inside the body as long as highly concentrated hydrogen is being inhaled.

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Author contributions

YI and BS designed and wrote the manuscript; FS and YT supported this study by giving advice and revising the manuscript. All authors read and approved the final manuscript.

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Declaration of conflicting interests

The authors declared the following potential conflicts of interest with respect to the research, authorship, and/or publication of this article: YI, BS and FS are employees of MiZ Company limited. The remaining authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Supplemental Material

Supplemental Material for this article is available online.

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