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THE ROLE OF
**HYDROGEN
INHALATION
THERAPY**

In Treating Traumatic Brain
Injury



INTRODUCTION

Traumatic brain injury (TBI) causes a change in the brain's functioning or is simply another example of brain pathology caused by an external force. More than 50 million people are suffering from TBI across the globe. Going by the predictions, about half of the population will get TBI once or even more in their lifetime. The leading causes of this are morbidity, disability, and mortality in all age groups in all countries, which increases the burden on society and families. Moreover, it has also become a global public health concern and medical issue.

Its clinical symptoms may vary from a severity perspective based on the level of brain damage. Survivors suffer from long-term physical, cognitive, and psychological dysfunction. TBI can be classified into two categories: primary and secondary types of brain injury. The primary injury is caused by specific mechanical forces that happen at the moment of insult and eventually disrupt brain cell integration. A series of events occurred, including releasing excitatory amino acids and opening the Ca^{2+} channel. It further generates free radicals and lipid peroxidation and releases inflammatory cell mediators, apoptosis, and so on.

These mechanisms have simultaneous effects and help constitute a chain reaction. These events lead to brain edema, ischemia, and cytotoxic cell swelling and give rise to intracranial pressure and result in secondary injury after TBI. It is the leading cause of a person's death after brain injury. Primary injury is caused due to specific mechanical forces that simultaneously cause it at the moment of insult and disrupt the integration of brain cells. A series of events happened, including releasing excitatory amino acids and opening the Ca^{2+} channel. It helps generate free radicals and lipid peroxidation and releases inflammatory cell mediators, apoptosis, and so on.

Apart from having simultaneous effects, these mechanisms constitute a chain reaction. Any injury can be prevented and reduced by primary brain injury. Investigations into secondary damage following TBI are critical because they help us determine the therapeutic target of TBI and improve prognosis. Hydrogen is a colorless, tasteless, and reductive small molecular gas. It has a therapeutic role in mouse skin cancer models by scavenging hydroxyl radicals.



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The Impact of Hydrogen Gas

Inhaled hydrogen gas (H₂) is proven to have significant protective effects on ischemic organs. Clinical trials abroad have shown promise that specific health issues like stroke, cardiac arrest, or heart attacks help benefit from inhaling hydrogen gas during the early recovery period.

How Hydrogen Gas Helps in Treating Traumatic Brain Injury

Hydrogen gas could reduce cerebral ischemia-reperfusion injury by reducing cytotoxic reactive oxygen species. It has opened a new chapter in medical research and application. Many studies have shown that hydrogen plays a therapeutic role via the mechanism of antioxidant stress in diseases like central nervous system diseases, respiratory system diseases, cardiovascular system diseases, digestive system diseases, urinary system diseases, and other diseases.

Central nervous system diseases are the focus of hydrogen medicine research. Brain tissue is vulnerable to oxidative stress compared to other body organs due to its high oxygen consumption, low antioxidant enzymes, and high content of unsaturated fatty acids. There is no fixed antioxidant available for treating nervous system diseases.

Hydrogen offers the benefits of easy access, diffusion, quick onset, and no toxicity. It provides a new idea for preventing and treating nervous system diseases. It discusses the role of hydrogen in TBI, elaborates on its potential mechanisms, and puts forward current understanding and views for future research.

Methods/Treatment for Treating Traumatic Brain Injury & Nervous System Diseases



Application of Hydrogen to Central Nervous System Diseases

Since 2007, due to the moderate reduction activity of hydrogen, which quickly diffuses via the blood-brain barrier. Due to it, more and more researchers have focused on the application of hydrogen in the treatment of central nervous system diseases.

Stroke is a severe acute cerebrovascular disease caused by occlusion or rupture of cerebral blood vessels, including ischemic and hemorrhagic stroke. The key elements of stroke pathophysiology are oxidative stress, inflammatory response, mitochondrial damage, and apoptosis. In the same year, Ohawa and colleagues first reported that inhalation of hydrogen markedly suppressed brain injury.



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Therapeutic Effects of Hydrogen on Traumatic Brain Injury

The use of hydrogen in TBI treatment began in 2010. The first study reported that hydrogen could exert neuroprotection in a rat model of controlled cortical impact (CCI) brain injury. Inhalation of 2% hydrogen between 5 minutes and 5 hours significantly attenuated blood-brain barrier damage, brain edema, lesion volume, and improved neurological outcome after the TBI.

Mechanisms of Hydrogen Therapy in Traumatic Brain Injury

TBI is a significant cause of death and disability among young people across the globe. The survivors of TBI have neurological deficits, behavioral changes, seizures, cognitive impairment, and so on. All this seriously affects the quality of life and brings a heavy burden to both society and family. It is a complex disease owing to the heterogeneity of brain injury and neuroendocrine dysfunction. Its underlying pathophysiological mechanism that occurs in TBI is more complicated.

CONCLUSION

The neuroprotective effect of hydrogen after TBI has been studied by conducting several experiments and research. Its potential mechanisms are related to anti-oxidation, anti-apoptosis, anti-autophagy, and regulation of cell signaling pathways. Hydrogen is non-toxic, reductive, and easy to diffuse. It is a promising gas that helps in treating TBI. Several studies and research have been done based on the function of hydrogen in TBI, which focuses on antioxidant stress. The pathophysiological mechanism of TBI is complex. Hydrogen has a pivotal role in TBI through other means and remains to be studied in detail and offers a theoretical basis for using hydrogen for treating TBI.



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