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Hydrogen Peroxide Technology and Wellness Services: Research on Innovation and Application Models of Intelligent Oxygen Therapy Equipment in the Context of Industry-Education Integration

Junhong Li[1], Yejin Li[2], Yuhao Chen[2], Qinxiu Wang[2], Chao Li[2]*

[1]Henan Mechanical and Electrical Vocational College, Zhengzhou 450000, Henan, China
[2]Shanghai Jian Qiao University, Shanghai 201306, China

**Corresponding author:* Chao Li, chao3655@qq.com

Abstract: With the upgrading of healthcare industry demands and the deepening of industry-education integration policies in China, the technological innovation and service model integration of intelligent oxygen therapy equipment have become a key path to address industry bottlenecks. This study focuses on the "oxygen-enriched + negative oxygen ion" composite device (abbreviated as "dual-oxygen equipment"), exploring its innovative design and healthcare applications under industry-education integration. Research shows that this equipment, through a triple physical purification system combining "activated carbon adsorption + negative oxygen ion deposition + active silver ion sterilization" with nebulization rehabilitation functions, effectively enhances non-pharmacological intervention outcomes for chronic respiratory diseases. With 93% oxygen-enriched output capacity and PM2.5 purification efficiency ≤35 μg/m^3, it provides reliable technical support for community and home-based healthcare scenarios. Additionally, the collaborative "R&D-talent-service" closed-loop mechanism between schools and enterprises—through joint laboratory construction, development of occupational standards, and service package design—has achieved full-chain breakthroughs from technical prototypes to industrial applications of intelligent oxygen therapy equipment, offering replicable practical paradigms for high-quality development in the healthcare industry.

Keywords: Oxygen enrichment; Negative oxygen ions; Industry-education integration; Oxygen production equipment; Wellness services

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1. Introduction: Technological gaps in the upgrading of healthcare industry and opportunities for industry-education integration

China's population is undergoing accelerated aging. As of 2023, the proportion of people aged 60 and above has exceeded 20%, with chronic respiratory diseases (including COPD and asthma) showing a steady annual increase. Traditional healthcare services face dual challenges: insufficient technological application and a shortage of specialized professionals [1]. As an emerging field integrating biomedical science, environmental engineering, and health management, intelligent oxygen therapy devices require urgent collaborative efforts among industry, academia, and research institutions to achieve technological breakthroughs and establish service models.

The hydrogen dioxide device innovatively combines "physiological oxygen supply" with "negative ion environment creation," expanding its functionality from basic oxygen delivery to integrated solutions encompassing "healthy environment cultivation and rehabilitation interventions." This technological advancement not only provides synergistic support for R&D through industry-education collaboration but also addresses the talent shortage in healthcare services via school-enterprise joint talent development mechanisms, serving as a crucial bridge between technological innovation and industrial application. Based on the device's R&D and practical implementation, this paper systematically analyzes the innovative value of hydrogen dioxide technology and implementation pathways for industry-education integration, aiming to provide a reference for the industrial promotion of intelligent healthcare devices.

2. Core of hydrogen peroxide technology: Functional innovations and performance metrics of intelligent oxygen therapy equipment

The core advantages of the hydrogen equipment lie in the technical design of "hydrogen synergy" and "multi-functional integration," and its performance parameters are closely set around the actual needs of the health care scenario, including the following four aspects.

2.1. Hydrogen peroxide synergistic mechanism: Simulating a healthy "forest air" environment

Through the coordinated control of the oxygen production module and the negative oxygen ion generation module, the device achieves a double health effect:

Oxygen supply: The output oxygen concentration is not less than 21%, and can be adjusted to 93% high concentration oxygen state according to the need, to meet the oxygen supply needs of different groups (such as hypoxia patients and healthy people);

Release of negative oxygen ions: The concentration of negative oxygen ions is stable at more than 5,000/cm3, reaching the standard of "healing air" defined by the World Health Organization [2], which has the dual effect of improving blood oxygen utilization and psychological relief.

2.2. Triple purification system: Blocking airborne transmission risks

The respiratory health protection barrier is constructed by adopting the composite purification technology of "physical adsorption + ion precipitation + chemical sterilization."

Activated carbon adsorption: effectively removes odors and volatile organic compounds (VOCs) and other harmful gases in the air;

Negative oxygen ion deposition: promotes the charging and aggregation of PM2.5 and other particulate matter and precipitation, with a purification efficiency of ≤35 μg/m3;

Active silver ion sterilization: by destroying the cell membrane structure of bacteria and viruses, reduce the risk of respiratory tract infection.

2.3. Nebulization rehabilitation: Precision intervention for chronic respiratory diseases

The combination of oxygen-rich air and medical-grade water vapor nebulization forms a "oxygen therapy + nebulization" collaborative intervention program:

Suitable for patients with chronic obstructive pulmonary disease (COPD) and asthma, it can deliver moist and oxygen-rich air by nebulization to relieve airway dryness and hypoxia symptoms.

Clinical trials demonstrate that this intervention can improve FEV1 (forced expiratory volume in 1 second) by 12% in COPD patients, while maintaining blood oxygen saturation above 96% [3].

2.4. Humanized design: Meeting the needs of multiple scenarios for health and wellness

The device is optimized for size, noise, and mobility to improve the actual experience:

Low noise operation: the working noise is controlled within 43 dB ± 3, which meets the requirements of a quiet environment for home and community health care centers.

Compact design: with dimensions of 620 mm × 400 mm × 1295 mm, it occupies minimal space and facilitates spatial layout.

Mobile convenience: equipped with omnidirectional wheels, which are easy to move in different scenarios, such as the home bedroom and community rehabilitation area.

3. Industry-education integration model: A path from technology development to service implementation

In order to solve the problems faced by intelligent oxygen therapy equipment, such as "difficult to research and develop, difficult to implement, and lack of talents," the research team has built a "university-enterprise collaboration, education and application" industry-education integration mechanism, forming a full chain transformation path from technology research and development to health care services.

3.1. University-enterprise collaborative R&D: Overcoming technical bottlenecks and establishing technical standards

Colleges and universities and enterprises work together to realize the effective connection between scientific research innovation and engineering implementation:

Technological breakthrough: University research teams spearheaded core technology development, including optimizing hydrogen peroxide concentration ratios and iterating active silver ion sterilization materials, which increased the oxygen output concentration of the equipment from 30% to 93%. The enterprise provided engineering support, handling structural design and mass production process optimization, while collecting clinical data feedback to drive technological improvements.

Joint construction of the platform: jointly establish the "Intelligent Health Care Equipment Laboratory," carry out experiments such as verification of the effectiveness of the nebulization rehabilitation program and purification efficiency test, and form the draft of "Technical Requirements for Intelligent Oxygen Therapy Equipment."

3.2. Talent development loop: Aligning with industry needs and optimizing functions through feedback

Establish an integrated talent development mechanism of "teaching-practice-feedback" based on job requirements:

Course development: Vocational colleges offer courses such as “Operation and Maintenance of Intelligent Oxygen Therapy Equipment” and “Health and Wellness Service and Health Management,” with enterprise technicians participating in teaching to impart practical skills such as equipment operation and troubleshooting.

Internship practice: Organized students to go into the community health and wellness center for an internship, participated in equipment operation and user health data collection, and served more than 2,000 elderly people in total.

Feedback: Students will collect user requirements (such as simplifying the operation interface, adding remote alarm function, etc.) during the internship and report them to the R&D team, so as to promote the continuous optimization of the equipment function and form a virtuous cycle of “talent training, service practice, and technology iteration.”

3.3. Service model innovation: From “equipment sales” to “comprehensive health services”

With the professional talents trained by the integration of industry and education, the equipment is transformed from a single product to the “equipment + service” model:

Develop “intelligent oxygen therapy + health management” service package: professional personnel trained by the university will make personalized oxygen therapy plans for users, regularly monitor blood oxygen, lung function, and other indicators, and establish health records.

Implementation: Equipment was deployed in community wellness centers across 5 cities in 3 provinces. Data shows a 18% reduction in respiratory infections among elderly residents in service areas, with operating costs 40% lower than traditional medical oxygen therapy devices [4].

4. Practical results and challenges

4.1. Main practical results

Improved technical economy: the equipment’s daily energy consumption is ≤8.4 kW·h (calculated at 350 W × 24 h), and the operating cost is reduced by 40%, which is economically feasible for large-scale promotion.

Remarkable health benefits: In community settings, the application not only reduces respiratory infections among the elderly but also alleviates anxiety through hydrogen-rich environment regulation (with a 30% decrease in SAS scores) and enhances cognitive performance (18% improvement in attention test accuracy) [5].

4.2. Key challenges

Core components are imported: the high-end oxygen concentration sensor and core components of the negative oxygen ion generator used in the equipment are still imported, which has a high cost and supply chain risk.

Clinical evidence remains incomplete: Current health effect data for the device primarily derive from observational studies. Future randomized controlled trials (RCTs) are required to further validate its efficacy in specific patient populations, such as those with early-stage Alzheimer’s disease.

5. Conclusion and outlook

This study uses the “oxygen-enriched + negative oxygen ion” device as a case study to demonstrate the core value of the “Oxygen Technology + Industry-Education Integration” model in innovating and applying smart health care devices. The Oxygen Technology achieves multi-dimensional health improvements through the synergistic effects of “physiological oxygen supply + negative oxygen ion regulation.” Meanwhile, the Industry-Education Integration mechanism establishes a complete chain from “technology R&D–talent cultivation–service implementation,” providing crucial support for the industrialization of such devices.

Future research can be advanced in the following three aspects:

Technology autonomy: Strengthen the cooperation between universities and enterprises, promote the localization of core components such as high-end sensors and negative oxygen ion generators, and reduce the dependence on imports.

Function expansion: Develop a remote diagnosis and treatment module to realize remote monitoring of device parameters and real-time transmission of user health data, and improve the intelligent level of service.

Business model innovation: Explore the “equipment leasing + health service” light-asset operation model, reduce the procurement threshold of health care institutions and families, and further expand the coverage of services.

Disclosure statement

The authors declare no conflict of interest.

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