

# The Application of High Technology and Artificial Intelligence in the Mental Health Management of Female Rare Cancer Patients

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**Abstract:** Female patients with rare cancers face multiple psychological pressures caused by the rarity of their diseases, including lack of information and insufficient social support. Traditional psychological intervention models struggle to provide timely, continuous, and personalized support. This study explores the application value of high technology and artificial intelligence in managing the mental health of this patient group. By analyzing key technologies such as AI chatbots, virtual reality, wearable devices and the Internet of Things, as well as big data and machine learning, a psychological health management system based on artificial intelligence was constructed. The research findings indicate that these technologies can provide continuous companionship and communication, personalized psychological therapy, real-time health monitoring, and precise interventions. They show significant advantages in emotional regulation, disease education and self-management, social support, and remote care, effectively addressing the unique psychological needs of rare cancer patients. However, challenges such as limitations in technological accuracy, lack of cultural adaptability, and varying levels of patient acceptance still require attention. Future development should focus on creating a more flexible and inclusive technological ecosystem, emphasizing human-machine collaboration, and viewing technology as an effective complement to professional medical services, ultimately achieving an "invisible" mental health management model.

**Keywords:** Artificial Intelligence; Female Rare Cancer; Mental Health Management; Intelligent Care

## 1. Introduction

Female patients diagnosed with rare cancers often find themselves in a unique predicament. Unlike those with common cancers, they struggle to access sufficient disease information online and have few peers with similar experiences to communicate with<sup>[1]</sup>. These patients face not only the physical challenges of the disease itself but also the compounded psychological pressures brought about by the rarity of their condition, such as a lack of information, insufficient social support, and uncertainties surrounding treatment. Due to the extremely low incidence of rare cancers, patients frequently endure prolonged periods of misdiagnosis in the early stages, which not only delays timely treatment but also exacerbates feelings of mistrust in the healthcare system and anxiety about their health status. Traditional psychological intervention models are limited by factors such as shortages in professional resources and uneven regional distribution, making it difficult to provide timely, continuous, and personalized support for this special group. Existing mental health service systems are primarily designed for common diseases and lack specialized mechanisms to address the distinct psychological needs of rare cancer patients. Moreover, patients with rare cancers often have to navigate multiple medical institutions to seek treatment, and this fragmented care experience further intensifies their psychological burden<sup>[2]</sup>. Against this backdrop, the rapid development of high technology and artificial intelligence offers new possibilities for improving the mental health management of rare cancer patients. The core value lies in leveraging intelligent tools to compensate for the shortcomings of traditional care models, enabling precise and dynamic psychological interventions.

The application of high technology and artificial intelligence in the field of mental health has already demonstrated considerable potential, especially in data-driven emotion recognition, real-time monitoring, and personalized interventions<sup>[3]</sup>. For female patients with rare cancers, these technologies are significant not only in alleviating common psychological issues such as anxiety and depression but also in constructing a comprehensive psychological assessment system by integrating multimodal data such as physiological indicators, behavioral patterns, and subjective reports. This system provides

objective support for clinical decision-making. AI systems specifically designed for rare cancer patients can integrate disease knowledge bases with psychological support features, offering instant responses when patients need them. Of course, technology can never fully replace the emotional connection between individuals, but it can serve as an important companion and source of information when professional staff are not available.

## **2. Key Technologies of High Technology and Artificial Intelligence in Mental Health Management**

### ***2.1 AI Chatbots***

The core value of AI chatbots in providing psychological support for female rare cancer patients lies in their ability to offer continuous, companionship-like communication, which holds special significance for patients who are often in medical settings for extended periods. Traditional psychological counseling is limited by time and location constraints, while emotional fluctuations in patients frequently occur during the night or in daily life outside of hospitals, where professional therapists may not be available for timely response. AI chatbots, powered by deep learning technologies, continuously learn from patients' expressions and emotional patterns, enabling them to detect subtle changes in language, such as shifts in word choice, simplified sentence structures, or alterations in emotional tone. This recognition capability allows the system to perceive changes in the patient's psychological state even before they explicitly express their concerns<sup>[4]</sup>. More importantly, the non-judgmental nature of the chatbot creates a safe space for expression. Many patients find it easier to share negative emotions with a machine than with family or friends, as they do not have to worry about burdening others. Additionally, the system's memory function allows it to recall previous interactions, providing personalized topic guidance for ongoing psychological support.

Beyond these core features, AI chatbots can also integrate with wearable devices and environmental sensors to expand their contextual awareness, such as recognizing changes in heart rate, sleep patterns, or movement data that may indicate elevated stress or anxiety. By combining linguistic analysis with physiological signals, chatbots can form a more holistic understanding of the patient's psychological state, delivering timely interventions that address both expressed concerns and unspoken distress. For example, if a patient's language becomes unusually terse while their heart rate remains elevated for extended periods, the system might prompt a gentle inquiry or recommend a calming exercise, such as guided breathing or progressive muscle relaxation. Furthermore, by analyzing aggregated data over time, chatbots can help identify recurring emotional patterns, such as increased anxiety before medical appointments or emotional distress linked to specific treatment milestones, providing healthcare professionals with valuable insights for tailoring care plans<sup>[5]</sup>. Importantly, AI chatbots can act as a bridge rather than a replacement for human care, offering immediate support while ensuring that more complex emotional needs are escalated to qualified professionals when necessary. This complementary role enhances the accessibility and responsiveness of mental health care, particularly for patients navigating the uncertainties and challenges of rare cancer diagnoses.

### ***2.2 Virtual Reality (VR) Technology***

The breakthrough application of VR technology in psychological therapy lies in its ability to reconstruct patients' perceptual experiences. When patients wear VR headsets, they can engage in meditation exercises on a virtual beach or experience the relaxation effects of aromatherapy in a forest setting. These immersive experiences can activate neural pathways associated with positive emotions in the brain, generating physiological and psychological responses similar to those in real environments. The unique advantage of VR systems lies in their controllability and repeatability. Therapists can adjust various parameters of the virtual environment based on the specific needs of the patient, such as light intensity, sound frequency, or the complexity of visual elements, to achieve optimal therapeutic outcomes<sup>[6]</sup>. For patients who experience fear related to medical procedures, VR can provide gradual exposure opportunities, allowing them to become familiar with the upcoming treatment process in a virtual setting, thereby reducing anxiety during the actual procedure. Furthermore, the system can record physiological response data from patients across different virtual scenarios, providing objective insights for optimizing treatment plans. This personalized adjustment mechanism is something that traditional psychological therapy methods struggle to achieve.

### **2.3 Wearable Devices and Internet of Things (IoT) Technology**

The key advantage of wearable devices in monitoring the mental health of female rare cancer patients lies in their ability to capture subtle physiological signals that patients themselves may not even notice. Many patients tend to hide or deny their emotional distress, especially in medical settings where they often display a strong front to reduce family members' worries. However, changes in emotional state leave difficult-to-conceal traces at the physiological level: for instance, a decrease in heart rate variability often indicates rising stress levels, while abnormal fluctuations in skin conductance may reflect accumulated anxiety<sup>[7]</sup>. These subtle physiological changes are continuously recorded through high-precision sensors, creating a unique baseline pattern for each patient. When the system detects abnormal deviations from this individual baseline, it triggers corresponding alert mechanisms—often earlier than the patient's own subjective perception. The integration of IoT technology enables real-time transmission of this data to the medical team, allowing caregivers to intervene before an emotional crisis occurs. More importantly, the long-term accumulation of data helps the medical team identify each patient's unique psychological fluctuation patterns, such as regular anxiety episodes a few days before treatment, providing scientific support for the development of targeted support plans.

### **2.4 Big Data and Machine Learning**

The greatest challenge of applying big data technology in the mental health management of rare cancer patients lies in how to extract valuable pattern information from limited samples—a task that highlights the unique value of machine learning algorithms. Traditional statistical analysis methods often struggle with small sample sizes, whereas deep learning models can, through transfer learning techniques, apply psychological health patterns learned from other patient groups to rare cancer patients, thus overcoming the problem of insufficient data. The system can simultaneously analyze patients' medical records, daily behavior data, and language expression content to construct a multidimensional psychological profile. For example, if a patient's posting frequency on social media suddenly decreases, their sleep data shows an increased number of nighttime awakenings, and voice analysis reveals a flattened tone of speech, the algorithm can integrate these seemingly unrelated pieces of information to identify potential depression risks<sup>[8]</sup>. The adaptive nature of machine learning models allows the system to continuously refine its prediction accuracy based on individual patient feedback—for instance, some patients' psychological states are primarily reflected through sleep patterns, while others are more evident in changes in social behavior. This ability to recognize personalized patterns is something traditional assessment methods cannot achieve and forms the technical foundation for precise mental health interventions.

## **3. Specific Applications of High Technology and Artificial Intelligence in Female Rare Cancer Patients**

### **3.1 Psychological and Emotional Management**

Artificial intelligence technologies address the complex psychological needs of patients by constructing a multi-level system for emotion recognition and intervention. Using natural language processing and affective computing, the system extracts emotional cues from patients' daily conversations, journal entries, and interactions with medical teams, building a dynamic emotional state profile. By integrating physiological sensor data, the system can detect inconsistencies between verbal expressions and physiological responses, identifying potential emotional suppression or denial. When emotional fluctuations exceed normal ranges, the system delivers personalized emotional regulation strategies based on the patient's individual characteristics and previously effective coping mechanisms<sup>[9]</sup>. These strategies may include progressive muscle relaxation, cognitive restructuring exercises, or connections to social support resources. For example, patients with malignant peritoneal mesothelioma, a rare abdominal malignancy often diagnosed in late stages due to its subtle and nonspecific early symptoms, typically experience significant psychological impact and anxiety about prognosis. AI systems, through analysis of language patterns in these patients, have identified common expressions of distrust toward the healthcare system, self-doubt in interpreting symptoms, and deep feelings of regret over missed treatment opportunities. The system responds by providing cognitive restructuring exercises that guide patients to shift focus from "what if" scenarios toward "what can be done now" action-oriented approaches. The system also adjusts intervention strategies according to the

patient's disease stage, emphasizing quality of life and future planning during stable periods, and providing support for acceptance and emotional adjustment during disease progression. This dynamic adjustment mechanism highlights the advantages of AI technology in delivering personalized psychological care.

### ***3.2 Disease Education and Self-Management***

Patients with rare cancers often experience cognitive challenges due to the scarcity of disease information, and traditional patient education models—typically using standardized information delivery—fail to address the diverse cognitive needs of patients at different stages of their illness. AI systems track patients' reading behaviors, question patterns, and comprehension test results to create personalized learning profiles, identifying which medical concepts are difficult for patients to understand and which treatment information they tend to avoid. The system pays particular attention to how emotional states affect learning outcomes; for instance, when a patient is in a highly anxious state, the system automatically simplifies information delivery, using more visual elements and analogies to reduce the psychological burden of complex medical terminology<sup>[10]</sup>. Moreover, the system recognizes patients' information preferences and learning habits—some prefer detailed scientific explanations to gain a sense of control, while others lean toward concise operational guidance and practical advice.

Developing patients' self-management abilities is a core goal of disease education systems, especially in the context of rare cancers that require long-term care. AI systems integrate patients' symptom logs, physiological monitoring data, and treatment response records to build dynamic disease management models capable of predicting symptom patterns and health risks under various circumstances. When the system detects abnormal fluctuations in a patient's physiological indicators, it immediately pushes relevant educational content, explaining potential causes and response strategies. This real-time educational support enables patients to better identify and manage health issues in their daily lives. The system also has a learning function that remembers patients' past successful coping experiences, prioritizing the recommendation of previously effective strategies when similar situations arise. Educational priorities are adjusted according to the patient's treatment stage: preoperative education focuses on preparation and psychological adjustment; during chemotherapy, the emphasis shifts to managing side effects and nutritional support; and in the recovery phase, it focuses on lifestyle modifications and relapse prevention. This phased education strategy ensures the relevance and practicality of the information provided.

### ***3.3 Social Support and Remote Care***

The sense of isolation experienced by rare cancer patients often stems from the lack of peers with similar experiences in their surroundings, and traditional face-to-face support groups are difficult to organize due to the dispersed geographic distribution of patients. AI-powered social matching systems can identify patients' disease types, treatment stages, age groups, and psychological characteristics across multiple dimensions to accurately match patients with similar backgrounds and experiences, helping them establish virtual support networks. This matching process not only considers the medical characteristics of the disease but also analyzes patients' communication styles, values, and life circumstances to ensure the effectiveness and sustainability of the connections.

Remote care systems integrate patients' daily life data, symptom reports, and emotional status records to provide healthcare professionals with a comprehensive patient profile, making remote consultations more targeted and personalized. By continuously monitoring patients' physiological indicators, symptom changes, and behavioral patterns, the system builds a multidimensional health status assessment model capable of identifying potential risks at an early stage. When abnormal signals are detected, the system automatically routes the case to the appropriate professional team based on the nature and urgency of the issue: psychological distress is referred to a psychological counselor, medication-related side effects are directed to a clinical pharmacist, and acute symptoms are escalated directly to the attending physician. This intelligent triage mechanism not only improves care efficiency but also ensures that patients receive the most appropriate professional support. The system's learning capability enables continuous improvement of care quality, as it analyzes the effectiveness of different interventions and patient feedback, allowing the algorithm to gradually optimize the timing and methods of care strategies.

## **4. Challenges and Countermeasures in Application**

### **4.1 Technological Limitations**

Current artificial intelligence technologies in mental health recognition still exhibit significant accuracy deficiencies, particularly when handling the complex and subtle emotional expressions of female rare cancer patients. Existing emotion recognition algorithms are primarily trained on datasets from healthy populations or common mental health conditions, lacking sufficient capability to identify the unique emotional patterns arising from cancer-related factors such as the disease itself, medication side effects, and treatment-induced stress. For instance, cognitive decline caused by chemotherapy may lead to speech hesitations or ambiguities, which AI systems might misinterpret as symptoms of depression or anxiety, thereby triggering unnecessary psychological interventions. The small-sample nature of rare cancer patients limits the availability of adequate training data for machine learning models, resulting in blind spots when algorithms encounter new symptom combinations or novel emotional expressions. Moreover, significant differences in emotional expression habits across cultural backgrounds further complicate the issue. Current systems often lack a deep understanding of cultural sensitivity, which may lead to misleading assessments in cross-cultural applications. These technological limitations necessitate that professional clinical judgment remain the primary decision-making authority in practice, ensuring that AI serves as a complementary tool rather than a substitute for human expertise.

### **4.2 Patient Adaptability**

Female rare cancer patients exhibit considerable individual differences in technology acceptance and usage capabilities, a reality often underestimated by technology developers. Older patients may feel confused when operating smart devices, and the cognitive load of learning new technologies becomes even more challenging during treatment periods. Chemotherapy and radiotherapy frequently cause cognitive impairments such as distractibility and memory decline, further compounding the difficulties patients face in learning and using new technologies. Some patients, long accustomed to traditional doctor-patient communication models, exhibit a natural aversion to machine-provided psychological support, perceiving technology as lacking human warmth and incapable of truly understanding their inner pain and fear. This psychological resistance often stems from misunderstandings about artificial intelligence and concerns over privacy breaches—patients may worry that their emotional expressions, once recorded and analyzed by machines, could be misused. Cultural background and educational level significantly influence patients' acceptance of technology, with some preferring to seek psychological support through family members or religious faith rather than relying on technological tools. Furthermore, the severity of a patient's illness directly affects their willingness and ability to use technological tools; when physical conditions deteriorate, even simple voice interactions may become a burden, and patients may prefer to devote their limited energy to emotional communication with family members.

Economic constraints also play a critical role and cannot be overlooked. The high costs of rare cancer treatments often impose a heavy financial burden on families, making it difficult for patients to afford additional technology devices or network service fees. Many families, when faced with overwhelming medical expenses, are forced to make difficult choices, and mental health technology services are often viewed as “non-essential” expenditures and excluded from priority considerations. Geographic location further exacerbates this inequality; patients in rural or remote areas not only face inadequate network infrastructure but also lack access to technical support and device maintenance services. Differences in social support networks also influence patients' reliance on technology—those with strong family support may have less need for technological assistance, while patients living alone or with limited social support are more likely to accept companionship and support provided by technology.

Addressing these adaptability challenges requires that technological solutions fully consider the realities of patients' circumstances, offering diverse interaction methods and flexible usage thresholds rather than prioritizing technological complexity and advancement. A successful technology application should be inclusive, capable of accommodating the needs of patients across different age groups, educational backgrounds, economic conditions, and health statuses. Through progressive guidance and personalized interface design, these technologies should aim to minimize usage barriers as much as possible, truly realizing the goal of equitable access to technology.

#### 4.3 Ethics and Dissemination

The application of artificial intelligence technology in mental health management raises a fundamental ethical dilemma: whether machines have the moral authority to handle deep-seated human emotional trauma. Female rare cancer patients are often in an extremely vulnerable psychological state, and their trust in technological systems is built on the perception of their professionalism and reliability. However, when AI systems make misjudgments or provide inappropriate suggestions, they may cause secondary harm to patients. The situation is further complicated by the highly sensitive nature of these patients' mental health data, which involves fears about their illness, anxieties about death, and complex emotional dynamics within family relationships. If such information is leaked, it can affect not only the patients themselves but also have psychological impacts on their family members. The issue of data ownership also warrants attention: when patients' emotional expressions, physiological responses, and psychological state changes are recorded and analyzed, it remains unclear under current legal frameworks whether this highly personal information belongs to the patient, the medical institution, or the technology provider. The lack of transparency in algorithmic decision-making further complicates matters, as patients often struggle to understand why the system provides certain recommendations. This "black box" nature can erode patients' autonomy, potentially leading to excessive reliance on technology at the expense of their own intuition and judgment.

The most significant barriers to technology dissemination lie within the healthcare system itself, particularly in divergent perspectives and uneven resource allocation. Many healthcare administrators question the return on investment for artificial intelligence technologies, especially for rare diseases—a relatively small patient population—where traditional cost-benefit analyses often fail to justify the investment. Frontline healthcare providers also show varying degrees of acceptance toward new technologies: older physicians may worry that technology could diminish the humanistic aspects of doctor-patient relationships, while younger medical staff may be more open to new tools but often lack experience in effectively integrating technology into clinical practice. A more critical issue is the vast disparity in digital capabilities across different regions and levels of healthcare institutions, leading to pronounced regional and hierarchical patterns in technology adoption. Rare cancer patients often require referrals between multiple institutions, yet inconsistencies in technology platforms and data standards across these institutions create information silos that limit the full potential of these technologies. Dissemination strategies must fully account for these practical constraints, adopting a gradual implementation approach rather than pursuing an immediate, all-encompassing deployment.

#### 5. Conclusion

This study demonstrates that high technology and artificial intelligence hold significant potential in transforming the traditional model of psychological care for female rare cancer patients. The core value lies in using technological means to address the fundamental issues faced by rare disease patients, particularly the lack of information and insufficient professional support. The effectiveness of these technologies largely depends on how well they align with the actual needs of patients, rather than the sophistication of the technology itself. At present, artificial intelligence systems still face notable limitations in the accuracy of emotion recognition and cultural adaptability, underscoring the importance of viewing technology as a supplement to professional medical services rather than a replacement. Future development efforts should focus on building a more flexible and inclusive technological ecosystem, with continuous improvements in areas such as cross-cultural adaptability, individual differences recognition, and human-machine collaboration mechanisms. Moreover, as learning algorithms and privacy-preserving computation techniques advance, the rare disease field is expected to overcome the limitations of small sample data and achieve more precise, personalized interventions. From a long-term perspective, successful mental health management technologies should be "invisible"—seamlessly integrated into patients' daily lives without imposing additional burdens, delivering proactive care and personalized support through intelligent systems. The ultimate goal is to establish a patient-centered, holistic mental health management model. This will serve as an essential benchmark for the future development of technologies and a fundamental objective in the continuous improvement of mental health services for rare cancer patients.

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