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Challenges and Opportunities in Mobile Health Technologies for Cancer Pain Management: An Integrative Review

Dahuang Tao[1]

1 Taizhou College

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Abstract

This article explores the evolving landscape of mobile cancer pain management, a critical aspect of healthcare innovation aimed at enhancing patient outcomes and accessibility to pain relief measures. Through a comprehensive analysis, the study examines the benefits, limitations, and potential strategies for overcoming the challenges associated with implementing mobile health technologies in the management of cancer-related pain. The discussion includes an evaluation of the effectiveness, patient adherence, and technological advancements in mobile health, alongside an assessment of the barriers hindering widespread adoption, such as cultural and technological literacy, resource allocation, and security concerns.

Dahuang Tao*

School of Medicine, Taizhou College, 318000, Taizhou, China

*Corresponding Author: 10086@tzc.edu.cn

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1. Introduction

Cancer pain is a chronic secondary pain syndrome caused by primary tumor damage, metastasis, or treatment, which can induce muscle, skeletal pain, and neuropathic pain. About 71% of cancer patients worldwide experience cancer pain in their daily activities [1][2][3][4]. Once cancer pain occurs, it may accompany the patient for life and interfere with the tumor treatment process, severely affecting the patient's physical and mental health and quality of life. The latest standards and guidelines emphasize the need for standardized comprehensive management of cancer pain patients, including pain assessment, coping guidance, and knowledge education [5][6][7][8][9][10]. However, due to the unpredictable timing and

severity of cancer pain episodes, traditional face-to-face management models cannot meet the patients' personalized analgesic needs timely and effectively. With the development of e-health, various information devices and health management platforms have emerged. Mobile Health (mHealth), as a branch of e-health, is defined by the WHO as the practice of providing health services through mobile devices and technology. It can overcome the limitations of traditional diagnosis and treatment in time and space and provide continuous, flexible, and efficient medical services [11][12][13][14][15][16]. Cancer pain management under mobile health technology offers personalized services such as pain assessment, feedback, and education for cancer patients with pain symptoms who have reading comprehension and verbal expression abilities and can correctly use mobile devices. This creates a platform for continuous cancer pain monitoring and real-time management, showing good application prospects in the cancer pain population. Based on domestic and international research, this article reviews the application of mobile health technology in cancer pain patients, summarizing from three aspects: management team, management form and content, and implementation effects, and proposes existing deficiencies and suggestions to optimize and promote mobile health cancer pain management.

2. Mobile Health Technology Under Cancer Pain Management Team

Cancer pain management based on mobile health technology is completed by a multidisciplinary team consisting of clinical doctors, pharmacists, nurses, and IT personnel. The core managers of the team are doctors and pharmacists with experience in cancer pain diagnosis and treatment, responsible for patient disease monitoring, analgesic drug scheme formulation, and adjustment [17][18][19][20]. Nurses, as assisting forces, are responsible for patients' online cancer pain assessment, health education, and information feedback, but their qualification standards have not yet been unified. Some literature indicates that nurses involved in mobile cancer pain management need to have more than three years of oncology work experience, have received professional training in cancer pain management, and have good communication and computer operation skills. IT personnel mainly include medical information researchers or software engineers who are responsible for the development and design of mobile health products in the early stage and for the maintenance and update of product functions during the management implementation phase, providing technical support for the smooth conduct of mobile cancer pain management.

3. Mobile Health Technology Under Cancer Pain Management Form and Content

3.1. Applications

Applications can be divided into mobile social applications and mobile health applications. Cancer pain management based on mobile social applications uses common mobile social software in people's lives as a medium to convey health information and enhance the connection between managers and patients [21][22][23][24]. Some scholars have used social software to conduct reinforced education for patients, posting knowledge about pain assessment methods, pharmacological effects of analgesic drugs, and adverse reactions on their public platform, and communicating with

patients in a timely manner [25][26][27][28][29]. To improve patients' cancer pain management capabilities, interactive cancer pain coping skills training has been conducted for patients with persistent cancer pain using the video communication function of social software. These studies based on social software for cancer pain management mainly focus on cancer pain knowledge education and method guidance, with limited content, but high patient participation and acceptance, and high accessibility of cancer pain management.

Mobile health applications are management software developed for cancer pain patients, featuring medication reminders, pain assessment, and real-time communication functions. Compared to social software, mobile health applications have more comprehensive monitoring and management functions, but the development of applications requires technical support from multidisciplinary teams, with higher economic and technical costs, and initially requires patients to learn how to use the software [30][31][32][33][34][35]. Scholars have developed a mobile application in this field, which not only uses electronic scales to monitor cancer pain but also has real-time communication, personalized guidance, and intelligent reminder functions. Various applications tailored for cancer pain patients have shown good management effects.

3.2. Telephone

The telephone, a common communication tool in daily life, also serves as a convenient and timely digital communication method in the medical and health field. In one study, nurses used the telephone to conduct one-on-one cancer pain assessments and provide patients with medication usage recommendations [36][37][38][39][40]. Additionally, some research has utilized interactive voice response systems for automated cancer pain monitoring, which are telephones capable of making automated outbound calls supported by computer technology. Once connected, these phones play pre-recorded voice messages and complete the cancer pain assessment following voice prompts. Compared to manual phone calls, interactive voice response systems have advantages in saving human resources and medical costs. Previous studies combined text messages and phone calls to monitor homebound cancer pain patients, reminding them via text message of an impending cancer pain assessment call. Five minutes later, an interactive voice response system would play voice content, prompting patients to complete the assessment using their phone keypad. Results indicate this as an effective monitoring method that can timely identify cancer pain and improve cancer pain registration rates.

3.3. Internet Platforms

Cancer pain management based on internet platforms integrates "network technology" and "disease management" into the monitoring of cancer pain symptoms, skill training, and health education. Someone created a website that integrates a pain diary, pain education, and online consultation to meet the different needs of cancer pain patients by integrating the functionalities of different modules. Internet platforms can facilitate the connection between doctors and patients, allowing patients to record their pain levels, medication usage, and adverse reaction symptoms online, browse information related to cancer pain, and communicate with doctors in chat windows, providing a free and flexible management approach. Additionally, someone has created a self-help psychological education website covering psychological education, relaxation guidance, symptom self-monitoring, and peer interaction, where patients can participate in modules of interest

according to their personal preferences.

3.4. Others

Other application forms include Virtual Reality (VR) technology and wearable devices. VR can use computer simulation technology to generate a virtual world, engaging human senses such as vision, touch, and hearing, providing diverse stimuli to divert individual attention from painful stimuli to neutral or pleasant events. The application of wearable devices in cancer pain management is still in the exploratory stage, but some studies show that respiratory monitors can alleviate cancer pain patients' pain, anxiety, and stress levels to some extent.

4. Implementation Effects of Cancer Pain Management Under Mobile Health Technology

The main evaluation indicator of mobile cancer pain management effectiveness is the severity of pain, with the Pain Numeric Rating Scale and the Brief Pain Inventory commonly used assessment tools. Due to the subjective nature of pain assessment, some studies have used multiple pain scales to increase the accuracy of assessments, while others have used objective physiological indicators to reflect the intensity of pain, such as respiratory rate and pro-inflammatory cytokines like IL-6, TNF-α, and IL-1β. Furthermore, self-efficacy in pain control, treatment adherence, physical function, and mental health status are also common evaluation indicators.

4.1. Alleviating the Severity of Cancer Pain

Cancer pain management based on different mobile health technologies can alleviate patients' pain symptoms. Analysis results show that applications with instant messaging functions can significantly reduce patients' pain scores; other studies indicate that applications are beneficial for assessing momentary pain, providing more accurate and reliable data than retrospective pain assessments. Scholars have demonstrated through systematic reviews that VR technology has significant potential in alleviating the pain levels of cancer patients. Scholars have developed a "gamified" cancer pain management software with child-like interest for adolescent cancer pain patients, requiring them to use the application at least twice a day. After one month, their pain levels were significantly relieved. These research conclusions suggest that mobile health technology can effectively alleviate pain in cancer pain patients of different age groups, but there are fewer studies related to underage cancer pain patients, and the evidence of effectiveness is not yet sufficient; further validation should be conducted in the future.

4.2. Improving Self-Efficacy

Self-efficacy is an individual's firm belief in their own abilities. Research shows that the level of self-efficacy in managing cancer pain in patients is low, meaning that a significant proportion of cancer pain patients believe they do not have the capability to successfully manage their cancer pain. Mobile cancer pain management can transmit knowledge information to patients, enhancing their cognitive level; assist patients in practice to accumulate successful analgesia experiences,

enhance their sense of control over cancer pain, and establish positive beliefs in pain control. Someone conducted pain coping skills training for cancer pain patients via video conference, including pain education, cognitive restructuring, skill instruction, and relaxation training, resulting in increased self-efficacy in cancer pain management among patients.

4.3. Improving Medication Adherence

The WHO stipulates that opioid medications are the standard treatment method for moderate to severe cancer pain, requiring patients to strictly follow medical advice in taking the medication. Both misuse and discontinuation can lead to poor control of cancer pain, making medication adherence a significant factor affecting the control of cancer pain. Mobile cancer pain management can remind patients to take their medication on time and monitor their medication use. A study using a mobile management program on 19 cancer pain patients for drug monitoring showed that the intervention group had significantly improved medication adherence rates. Remote cancer pain management via WeChat not only can improve patient medication adherence but also can alleviate adverse reactions of opioid medications, such as constipation, nausea, vomiting, and dizziness. Mobile cancer pain management platforms can provide electronic health information related to medication adverse reactions, record symptoms, frequency, and severity of adverse reactions, and inform patients of coping methods, helping patients to take correct actions in a timely manner and reduce the incidence of adverse effects. For example, if patients experience constipation symptoms after taking pain medication, they can search for constipation-related coping methods on the management platform or report their personal situation with constipation, receiving personalized guidance to alleviate their symptoms through timely adjustments to their diet, bowel habits, and use of laxatives. Therefore, mobile health cancer pain management can effectively enhance patients' initiative and correctness in participating in cancer pain medication management, optimizing their cancer pain management behavior and holding significant potential in alleviating medication adverse reactions.

5. Shortcomings of Mobile Health Technology in Managing Cancer Pain

5.1. Limited Monitoring Content

Cancer pain monitoring is an essential component of mobile cancer pain management, allowing for understanding patients' post-discharge cancer pain control. However, current cancer pain monitoring is limited to subjective indicators such as pain intensity and medication adverse reactions, assessed via patient self-report, making it difficult to objectively and real-time monitor the condition of cancer pain. A recent systematic review indicated that cancer patients' perception of pain is positively correlated with systolic blood pressure, heart rate, and low-frequency/high-frequency heart rate variability (LF/HF) indicators; galvanic skin response is also considered assessable for cancer pain, as sympathetic nervous system excitation signals caused by pain increase sweat gland secretion and skin conductance, causing changes in skin electrical activity. This suggests that real-time monitoring of physiological indicators such as blood pressure, heart rate, and skin electrical activity can, to some extent, objectively quantify cancer pain. Wearable devices have significant advantages in real-time monitoring of physiological indicators, relying on hardware and software systems such as sensors,

flexible components, and communication modules, capable of automatically sensing, recording, analyzing, and managing data, enabling continuous monitoring of objective physiological indicators in cancer pain patients. Therefore, developing wearable devices suitable for cancer pain monitoring and management is significant, such as cancer pain smart bracelets and electronic fabrics, not only optimizing the content and form of mobile cancer pain monitoring but also offering advantages of portability and comfort.

5.2. High Risks in Diagnosis and Treatment Decision-making

Compared with offline cancer pain management, mobile cancer pain management offers flexibility in time and location, meeting the daily monitoring needs of cancer pain patients. However, there are risks of omissions and errors when patients self-assess and report online, affecting the accuracy of information; simultaneously, the absence of physical examinations makes it difficult to make accurate judgments about patients' conditions. Therefore, there are considerable risks in cancer pain diagnosis and treatment based solely on mobile cancer pain management without ensuring that the online reporting basis matches the actual condition of the cancer pain patients, leading to inappropriate decisions. On one hand, patients should be supervised and reminded to report information truthfully and undergo regular standardized reporting training to improve the accuracy of subjective assessments. On the other hand, integrating mobile and offline cancer pain management organically to build a new model of cancer pain management is essential. In recent years, medical and health services based on the Online to Offline (O2O) model have developed rapidly. This model can connect online resources with offline physical medical services, achieving seamless health management inside and outside the hospital. Based on the O2O model, cancer pain management plays roles online, such as educating about cancer pain, tracking patient condition changes, reminding patients to seek offline medical attention, and connecting the cancer pain management system with clinical information systems and medication management information systems, to conduct outpatient and emergency appointments, online medication applications, etc., establishing a faster and more convenient medical model. Offline, it performs cancer pain diagnosis and treatment roles, where managers observe patients physically and access online records, comprehensively understanding the patients' cancer pain control situation, making reasonable cancer pain diagnosis and treatment decisions, and evaluating the accuracy of patients' online monitoring, further standardizing patients' mobile cancer pain management behavior, thereby forming a virtuous cycle and reducing the risks of inappropriate diagnostic and treatment decisions.

5.3. Obstacles to Promotion

Although mobile cancer pain management has overcome spatial and temporal barriers, increasing the accessibility of cancer pain management, its development and promotion still face some limitations. On one hand, the beneficiary population of mobile cancer pain management is limited. Mobile cancer pain management requires patients to have a certain level of education and the ability to operate smart devices, as well as the need for remote communication devices and environments. Therefore, cancer pain patients in rural areas, the elderly, and those with lower educational levels may not benefit from it. On the other hand, there is an uneven distribution of mobile cancer pain management resources. Currently, mobile cancer pain management technologies are mostly independently developed by high-level hospitals and

only applied to patients in their own institutions, leading to poor accessibility of mobile cancer pain management in lower-level hospitals. Additionally, factors such as online information security risks, insufficient promotion efforts, and low patient awareness about cancer pain also limit the promotion and application of mobile cancer pain management. The latest guidelines state that by 2030, telemedicine will cover medical and health institutions at the provincial, city, county, and township levels, meeting the needs for personalized services and precision medicine. This suggests that cancer pain management should develop in a more personalized direction, such as conducting telephone-based cancer pain management for elderly patients and illiterate patients who lack the ability to operate electronic devices. Moreover, there should be an expansion of service scope. Tertiary A-level hospitals should be responsible for the system development and maintenance of mobile cancer pain management, pilot operations should be conducted in hospitals at all levels within the region to promote the joint development of mobile cancer pain management services at different hospital levels, and the promotion efforts on the official platforms of various hospitals should be strengthened to increase the attention of patients and their caregivers to cancer pain management.

6. Conclusion

while mobile cancer pain management presents a revolutionary approach by transcending spatial and temporal barriers and enhancing the accessibility of pain management, its implementation and proliferation face significant challenges. Limited by factors such as the digital literacy of patients, the availability of technological resources, and uneven distribution of service resources, mobile cancer pain management currently benefits a restricted demographic. Furthermore, disparities in technology adoption between high-level hospitals and lower-tier medical institutions exacerbate access inequalities. Addressing these challenges requires a multifaceted approach, including the development of inclusive strategies that cater to patients with limited technological proficiency, expanding the scope of services to a broader range of healthcare facilities, and enhancing cybersecurity measures. By promoting personalized pain management solutions and intensifying efforts to raise awareness among patients and caregivers, the potential of mobile cancer pain management can be more fully realized, leading to improved patient outcomes and a reduction in the healthcare disparities associated with cancer pain management.

Statements and Declarations

Data Availability

The data used to support the findings of this study are included within the article.

Conflicts of Interest

The authors declare that there is no conflict of interest regarding the publication of this paper.

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