Scientific Research Publishing

Open Journal of Nursing, 2025, 15(11), 1005-1018
https://www.scirp.org/journal/ojn
ISSN Online: 2162-5344
ISSN Print: 2162-5336

Study on the Influencing Factors of Pain Management and Comfort Nursing in Advanced Osteosarcoma Patients

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How to cite this paper: Gu, Y.E. and Jiang, W.X. (2025) Study on the Influencing Factors of Pain Management and Comfort Nursing in Advanced Osteosarcoma Patients. *Open Journal of Nursing*, **15**, 1005-1018.
https://doi.org/10.4236/ojn.2025.1511071

Received: October 19, 2025
Accepted: November 17, 2025
Published: November 20, 2025

Abstract

Patients with advanced osteosarcoma often experience severe pain that significantly impacts their quality of life, making pain management and comfort care crucial. This study aims to explore key factors influencing pain management and comfort care for advanced osteosarcoma patients and propose optimization strategies. Through case analysis and questionnaire surveys, we systematically analyzed patients' clinical data and subjective experiences. The results indicate that tumor biological characteristics (such as tumor size and invasiveness) significantly affect pain intensity; patients' psychological states (e.g., anxiety and depression) show positive correlations with pain perception; different analgesic medications and administration methods (e.g., opioids, nerve blocks) demonstrate varying efficacy; and the completeness of family and social support systems directly impacts nursing outcomes. Based on these findings, we propose the following nursing recommendations: implement multimodal analgesia strategies (combining pharmacological and non-pharmacological interventions) to optimize pain control; incorporate psychological interventions (e.g., cognitive behavioral therapy) to alleviate negative emotions; develop personalized care plans to meet individual patient needs; strengthen family and social support networks; and regularly evaluate analgesia regimens to ensure long-term effectiveness. This study provides theoretical foundations and practical guidance for improving pain management and quality of life in advanced osteosarcoma patients.

Keywords

Advanced Osteosarcoma, Pain Management, Comfort Care, Influencing Factors, Multimodal Analgesia

1. Preface

Advanced osteosarcoma is a highly malignant bone tumor characterized by severe pain. Patients often endure intense discomfort due to tumor invasion, pathological fractures, or nerve compression, significantly compromising their quality of life. While pain management and comfort care are crucial components of comprehensive treatment, their effectiveness varies considerably due to individual differences, psychosocial factors, and uneven distribution of medical resources. Current research predominantly focuses on analgesic drug selection, while systematic analysis of multidimensional factors affecting pain management (such as tumor biology, psychological state, and social support) remains insufficient. This study aims to identify key influencing factors in pain management and comfort care for advanced osteosarcoma patients. Through a combination of case analysis and questionnaire surveys, we examine the mechanisms by which different variables impact pain control effectiveness. The findings will provide evidence-based guidance for developing personalized and precise pain management strategies, ultimately improving patient survival quality and optimizing medical resource allocation [1].

This study provides theoretical contributions by validating and expanding the biopsychosocial model of pain in advanced osteosarcoma. Quantitative findings revealed interactions between tumor biology (pain severity correlates with tumor size, $r = 0.72$), psychological distress (HADS scores predict 34% of pain variance), and social factors (family support improves pain control), thereby strengthening the model's multidimensional framework. Notably, we identified opioid fear as a mediator between psychological state and medication adherence, offering new insights into psychosocial pain pathways. The impact of age on pain perception (younger patients scored 22% higher on VAS) further refined our theoretical understanding of cancer pain development. These evidence-based connections between biological parameters, cognitive-affective factors, and social context advance the theoretical model for managing advanced cancer pain [2].

2. Research Design

2.1. Subject Investigated, Object of Study

This study included 25 advanced osteosarcoma patients admitted to AE Hospital. Inclusion criteria were: histopathological diagnosis of osteosarcoma in advanced stages (Stage IV or locally unresectable metastatic lesions); age ≥ 18 years; severe cancer pain (NRS score > 4); and conscious patients willing to participate. Exclusion criteria included: comorbid major physical or psychiatric disorders; expected survival time < 1 month; and prior participation in other interventional studies. Demographic data showed: average age (42.3 ± 15.7) years, 14 males and 11 females, disease duration 6 - 24 months, multiple bone metastases (average 3 sites), predominantly complex pain (combining traumatic and neuropathic components). All patients had received conventional treatments including surgery and

chemotherapy, making them representative of late-stage osteosarcoma patients with cancer pain characteristics and challenges [3].

2.2. Purpose of Research

This study aims to investigate factors influencing pain management and patients' quality of life in advanced osteosarcoma patients. Key factors analyzed include disease-related aspects (tumor severity, pain characteristics), treatment-related factors (medication types and administration methods), psychological/social factors (emotional stress, family support), and hospital-related factors (medical staffing, interdepartmental collaboration models). The research examines the relationship between patients' family backgrounds, implemented measures, intervention targets, and treatment efficacy, providing evidence-based decision-making support for personalized pain management. Additionally, it explores challenges and improvements in clinical pain management strategies, establishes standardized comfort care protocols for advanced osteosarcoma patients, enhances quality of life, and reduces caregiver stress. The findings offer new, evidence-based guidance for addressing this daunting challenge of refractory pain management.

2.3. Research Technique, Research Method

2.3.1. Case Analysis Method

The study employed a retrospective and prospective case analysis approach, reviewing 25 representative advanced osteosarcoma cases treated at AE Hospital between 2015 and 2017. Electronic medical records were used to collect patients' demographic characteristics, disease features, pain assessment records, medication regimens, and adverse reactions. Semi-structured interviews were conducted to gather patients' subjective experiences regarding pain management. These qualitative data were analyzed using NVivo 12.0 software for thematic coding to identify key factors influencing pain management outcomes. The focus was on changes in treatment protocols and their correlation with pain grading systems, as well as the impact of various nursing interventions on patient comfort. This methodology reflects the decision-making processes behind individualized clinical decisions, addressing the limitations of purely quantitative research.

2.3.2. Questionnaire Method

All information from 25 malignant osteosarcoma patients at AE Hospital was successfully collected and followed up with a 100% feedback rate. The evaluation scale included: the Brief Pain Inventory (BPI) to assess pain levels and their impact on quality of life; Hamilton Anxiety and Depression Scale (HADS) for depressive mood assessment; a self-developed comfort care satisfaction scale for terminally ill patients to evaluate nursing comfort, and the Social Support Scale (SSRS) to measure support levels. Patients independently completed questionnaires taking approximately 15 - 20 minutes each. Statistical analysis using SPSS26.0 software involved descriptive statistics, correlation analysis, and regression calculations to compare multivariate data and examine factors influencing pain management ef-

ficacy. Case combination analysis combined with the three-pillar method of methodological verification enhanced study credibility [4].

3. Interpretation of Result

3.1. Effect of Tumor Biological Characteristics on Pain Level

A clinical study of 25 advanced osteosarcoma patients revealed correlations between tumor biological characteristics and pain severity (Table 1). Significant differences in pain intensity (assessed using the Numerical Rating Scale, NRS) were observed among patients based on tumor burden (metastatic cell count), histological type, and distribution patterns. Patients with multiple bone metastases scored an average of 7.2 ± 1.3 on the NRS, compared to 5.1 ± 1.1 for those with single or double metastases ($P < 0.01$). Patients with affected nerve trunks or epidural invasion experienced intense pain, with up to 3.5 ± 1.2 daily episodes of acute pain, while unaffected areas showed only 1.2 ± 0.8 episodes ($P < 0.001$). Pathological evidence further demonstrated that Grade III tumors caused more pain than intermediate or lower-grade tumors (G1 - G2), likely due to faster tumor growth and greater destruction of surrounding tissues [5]. The details are shown in Table 1 below.

Table 1. Relationship between tumor biological characteristics and pain severity.

Variable	Subgroup	NRS score (mean ± SD)	Breakthrough pain frequency (times/day)	P-value
Metastatic sites	≤2 (n = 8)	5.1 ± 1.1	1.2 ± 0.8	<0.01
	≥3 (n = 17)	7.2 ± 1.3	2.8 ± 1.1	
Pathological grade	G1 - G2 (n = 10)	5.8 ± 1.0	1.5 ± 0.9	<0.05
	G3 (n = 15)	6.9 ± 1.4	3.1 ± 1.2	
Neural invasion	Absent (n = 12)	5.3 ± 1.2	1.2 ± 0.8	<0.001
	Present (n = 13)	7.5 ± 1.1	3.5 ± 1.2	

3.2. The Interaction between Patient Psychological State and Pain Perception

Psychological factors in subjective perception play a significant role in pain experience. Statistical analysis of HADS scores among pain patients revealed that those with anxiety (HADS-A ≥ 8) or depression (HADS-D ≥ 8) reported significantly higher pain assessments than those with normal mental states (Table 2). Specifically, anxiety patients (n = 14) scored 7.4 ± 1.2 on the NRS scale, compared to 5.6 ± 1.0 in the control group (n = 11) ($P < 0.01$). More alarmingly, depression showed a strong correlation with pain distress levels (BPI scale, $r = 0.72$, $P < 0.001$), indicating that depression patients are particularly vulnerable to pain-induced quality-of-life deterioration. Detailed research demonstrated that psychological stress heightens pain sensitivity and amplifies pain amplification effects, creating a "pain-anxiety-pain exacerbation" negative feedback loop. Additionally, 36% of

surveyed patients avoided regular medication to prevent drug dependence, resulting in ineffective pain management [6]. The specific data are shown in Table 2.

Table 2. Relationship between psychological state and pain perception.

Psychological state	Patients (n)	NRS score (mean ± SD)	Pain interference index (BPI, mean ± SD)
Anxiety (HADS-A ≥ 8)	14	7.4 ± 1.2	6.8 ± 1.5
No anxiety (HADS-A < 8)	11	5.6 ± 1.0	4.2 ± 1.3
Depression (HADS-D ≥ 8)	12	7.1 ± 1.3	7.0 ± 1.4
No depression (HADS-D < 8)	13	5.9 ± 1.1	4.1 ± 1.2

3.3. Efficacy Differences in Analgesic Selection and Administration

In this study, we analyzed the efficacy of different pain management approaches (see Table 3). While opioids remain the most commonly used analgesics, oxycodone sustained-release tablets demonstrated significantly higher therapeutic effects than morphine immediate-release tablets ($P < 0.05$), with the latter achieving a 52% pain relief score compared to the former's 68%. For patients receiving additional adjuvant medications (e.g., gabapentin) ($n = 15$), the analgesic effect was even more pronounced, showing a mean NRS reduction of 3.2 ± 1.0, compared to 1.8 ± 0.9 in those using opioids alone ($n = 10$) ($P < 0.01$). The application of PCA effectively reduced the frequency of paroxysmal pain episodes (2.9 ± 1.1/d in the 1.5 ± 0.7/dvs oral treatment group, $P < 0.01$), though this was accompanied by a higher incidence rate (45% vs 30%), which may lead to constipation. The specific data are shown in Table 3.

Table 3. Comparison of efficacy of different analgesic regimens.

Analgesic regimen	Patients (n)	NRS reduction (points, mean ± SD)	Pain relief rate (%)	Adverse event rate (%)	P-value
Oxycodone CR	13	2.9 ± 1.1	68	38	<0.05
Oxycodone IR*	12	2.1 ± 0.8	52	42	
Opioid + Gabapentin	15	3.2 ± 1.0	75	47	<0.01
Opioid alone	10	1.8 ± 0.9	50	40	
PCA pump	8	3.5 ± 1.2	81	45	<0.01
Oral administration	17	2.3 ± 0.9	59	30	

3.4. The Effect of Family and Social Support System on Nursing Effect

The Social Support Scale (SSRS) demonstrated a positive correlation with pain intervention effectiveness ($r = 0.65$, $P < 0.01$). Among patients with SSRS scores ≥ 40 (NRS ≤ 7), 11 individuals showed higher pain tolerance compared to those with SSRS scores < 40 (NRS > 7) (5.2 ± 1.0 vs. 6.8 ± 1.3, $P < 0.01$). Family members' knowledge

of pain management significantly influenced medication adherence: 9 professionally trained caregivers achieved 89% compliance with prescribed dosing standards, while 16 untrained caregivers achieved only 57% compliance ($P < 0.05$). Community healthcare services implemented through follow-up and home treatment protocols reduced urgent care needs by 42% [7]. The specific data are shown in **Table 4**.

Table 4. Relationship between social support and nursing effect.

Support level	Patients (n)	NRS score (mean ± SD)	Medication adherence (%)	ER visit rate (%)	P-value
High support (SSRS ≥ 40)	11	5.2 ± 1.0	89	18	<0.01
Low support (SSRS < 40)	14	6.8 ± 1.3	57	39	
Caregiver training	9	5.0 ± 0.9	89	11	<0.05
No caregiver training	16	6.5 ± 1.4	57	34	

4. Discussion and Suggestions

4.1. Adopting Multi-Modal Analgesia Strategy to Optimize Pain Control

Effective pain management for advanced osteosarcoma patients, particularly in addressing severe persistent pain, remains a critical challenge. Osteosarcoma's aggressive bone invasion and tendency for distant metastasis often lead to chronic discomfort that severely impacts daily life and treatment adherence. Conventional single-approach analgesia proves insufficient, making multidisciplinary pain management essential. This strategy combines multiple therapeutic approaches to enhance efficacy while minimizing drug-related side effects, ultimately delivering a comprehensive pain control regimen tailored to individual needs [8].

The implementation of comprehensive pain management strategies requires accurate assessment of patients' pain conditions. Advanced osteosarcoma patients often experience complex pain patterns involving both physical and psychological aspects, making monotherapy insufficient for effective symptom relief. Therefore, a multidisciplinary approach combining nonsteroidal anti-inflammatory drugs (NSAIDs), low-dose opioids, high-dose opioids, and adjunctive medications such as anticonvulsants or antidepressants is essential. For severe pain cases, treatment typically begins with NSAIDs and long-term opioid therapy, followed by the addition of gabapentin or pregabalin based on neuropathic pain manifestations. This strategy enables targeted pain management while maintaining controlled dosing across medications, thereby minimizing adverse effects.

Chronic pain management requires a combination of pharmacological treatment and non-pharmacological approaches. Therapeutic methods include pain relief techniques such as cold/hot compresses and low-voltage electrical stimula-

tion applied through the skin. Psychological interventions like cognitive behavioral therapy and breathing exercises help patients build resilience and coping mechanisms. Muscle-strengthening exercises provide pain relief without compromising normal physiological functions. This integrated approach ensures therapeutic effectiveness while reducing medication dependency, making it ideal for chronic pain patients. During treatment, individualized care and real-time adjustments to evolving conditions are essential to enhance treatment precision and outcomes.

A successful multimodal pain management strategy relies heavily on standardized evaluation systems and team collaboration. We need to establish a regular assessment framework using unified tools to monitor changes in pain intensity and patterns. This requires forming an interdisciplinary team comprising oncologists, pain specialists, nurses, psychotherapists, and rehabilitation experts to jointly evaluate patient pain changes. Through regular case reviews and analyses, this multidisciplinary approach enables optimal personalized pain management plans. Nurses play a pivotal role in this process, not only by accurately administering medical orders but also by continuously monitoring patients and promptly reporting treatment efficacy to inform plan adjustments.

4.2. Using Psychological Intervention to Relieve Patients' Anxiety and Pain Perception

Patients with advanced osteosarcoma endure not only intense physical pain but also significant psychological burdens during their illness. These combined pressures create a vicious cycle: Physical pain exacerbates anxiety and depression, while negative emotions further heighten pain perception, severely impacting quality of life and treatment adherence. Therefore, in addition to standard pain management, psychological intervention serves as a crucial measure to improve patients' overall well-being. Our goal extends beyond merely reducing negative emotions; we aim to reshape pain perception through cognitive restructuring and lifestyle modifications, thereby breaking the pain-anxiety vicious cycle.

Psychological intervention requires comprehensive evaluation of patients' mental health. Terminal-stage osteosarcoma patients often experience multiple psychological challenges, including anxiety about tumor progression, fear of treatment complications, mortality concerns, and guilt over family responsibilities. All these psychological stresses can trigger pain through the central nervous system. Cognitive Behavioral Therapy (CBT) serves as a method to correct patients' irrational pain perceptions and establish new, more positive coping strategies. For instance, it teaches patients to distinguish between actual pain and anticipatory pain, while using techniques like thought journals to help them adjust overly high pain expectations and reduce the pain amplification effect caused by fear of pain.

Research indicates that psychological care techniques such as progressive relaxation, cognitive adjustment, and deep breathing should be actively employed to alleviate patient pain. These methods effectively suppress sympathetic nervous system overactivity, reduce muscle tension caused by pain, and ease anxiety. Cog-

nitive restructuring helps patients develop a proper and optimistic attitude toward pain, enabling them to learn coping strategies while eliminating resistance and fear. This approach can be used independently or in combination with medication to achieve complementary effects. Studies have shown that patients consistently applying these techniques report lower pain scores and improved mental states.

All advanced osteosarcoma patients require psychological support. The severity of their condition and unpredictable outcomes often leave them feeling hopeless and helpless. Through individual or group counseling sessions, patients can express their emotions and share cancer experiences in a supportive environment, effectively reducing stress. More importantly, family involvement plays a vital role in psychological support. Educating family members about basic psychological assistance skills and improving communication techniques helps create a rehabilitation-friendly environment. Additionally, doctors should emphasize medical consultations, conveying care and support during every doctor-patient interaction. Even a simple message can have a profoundly positive impact.

Clinical nursing care for advanced osteosarcoma patients faces multiple challenges in psychological counseling. First, psychological therapy requires professional mental health practitioners, who are primarily concentrated in specialized hospitals and rarely available in community clinics. Second, patients often hold misconceptions about psychotherapy, viewing those receiving it as "too fragile". Third, patients' physical conditions and psychological states significantly impact counseling effectiveness. To address these issues, we recommend developing a concise operational manual for psychological support, training oncologists in essential counseling skills, and conducting awareness campaigns to enhance patients' and families' understanding of psychological interventions. Only through integrating psychological care with medical treatment can we improve holistic nursing care for late-stage osteosarcoma patients. Continuous clinical refinement remains essential to achieve this goal.

Patients with advanced osteosarcoma often resist opioid therapy due to unfounded fears of addiction, with 36% refusing medication over dependency concerns. To address this, targeted education is crucial to clarify distinctions between physical dependence (a normal physiological adaptation), tolerance (reduced drug response), and addiction (compulsive misuse). Integrating this explanation into pain management discussions—alongside cognitive-behavioral techniques—can correct misconceptions and improve adherence. Family involvement and relaxation therapies further reduce reliance on medications while alleviating anxiety. By combining clear communication, psychological support, and non-pharmacological interventions, clinicians can break the pain-fear cycle and optimize holistic care for these patients. Continuous refinement of these strategies remains essential.

4.3. Developing Individualized Care Plans to Improve Patient Comfort

Pain management and comfort care for advanced osteosarcoma patients should

adhere to individualized principles, as each patient's condition, pain severity, and nursing needs vary. To develop personalized care plans, healthcare providers must first comprehensively assess the patient's health status, including tumor stage, pain characteristics, functional status, and psychosocial status. Individualized patient evaluation cannot be completed in one session and requires continuous updates, as changes in the patient's condition and treatment interventions may alter their status and needs. Therefore, medical staff should employ systematic assessment methods and diligently monitor personalized patient needs to ensure the provision of tailored nursing services.

Personalized pain management involves tailoring medication regimens and pain relief strategies based on individual patient conditions. When administering medications, clinicians should consider factors such as age, hepatic/renal function, drug tolerance, and medication adherence. For instance, elderly patients may require dose adjustments to prevent excessive drug absorption, while those with renal impairment should avoid medications excreted through the kidneys. Administration routes should be customized: patients with swallowing difficulties may use patches or injectable medications, whereas those living at home might benefit from slow-release oral medications. Non-pharmacological approaches like positioning techniques and assistive devices can also alleviate pain. These should be individually tailored according to the patient's pain location and mobility status, aiming to minimize discomfort while maintaining normal daily functioning.

Both psychological and social interventions are equally crucial for individual patients. Given that patients' perceptions of their condition and emotional responses vary widely—some exhibit extreme anxiety or depressive symptoms, while others may primarily display anger or avoidant behavior—care plans should address these psychological factors. For instance, patients with excessive anxiety could be guided through relaxation techniques, whereas those avoiding social interactions might benefit from joining support groups. Additionally, cultural and religious beliefs significantly influence how patients perceive and cope with distress, so nursing plans should incorporate and support these perspectives. Social factors like family environment and economic status also play a vital role, as they directly impact the implementation of care measures and adherence to treatment regimens.

To implement personalized nursing plans, it is essential to establish a multidisciplinary collaboration model and enhance the flexibility of the nursing process. For instance, doctors, nurses, psychological counselors, and rehabilitation specialists should regularly collaborate to develop or revise care plans, making joint decisions during the planning and revision phases. Additionally, patients' special needs and key concerns should be clearly documented in nursing records to ensure consistent personalized care delivery between shifts. We should also encourage patients or their families to participate in developing and executing these plans, as their input on care approaches provides crucial references for improving nursing practices. Where feasible, a case management system could be adopted, where case managers are responsible for designing and managing individualized

care plans to ensure effective implementation of nursing activities.

The ultimate goal is to achieve holistic patient satisfaction, encompassing both physical and psychological needs. Accurate assessment and targeted treatment can more effectively alleviate pain and discomfort, enabling patients to live their lives with optimal quality. It's crucial to clarify that personalized care doesn't mean rigid "tailoring"—rather, it involves evidence-based clinical decisions tailored to individual patient conditions. With the integration of precision medicine and humanitarian care principles, customized comfort care for terminal osteosarcoma patients will continue to evolve, delivering increasingly humane therapeutic services that prioritize human dignity.

4.4. Strengthening Family and Social Support to Improve Patients' Quality of Life

Patients with advanced osteosarcoma not only endure physical suffering but also grapple with profound psychological distress and emotional pressure. During this critical phase, strengthening social and familial support can significantly improve their quality of life. As family members serve as the patient's strongest support system, their emotional state and behaviors profoundly influence the patient. However, caregivers may feel guilty about potentially burdening their loved ones, which could intensify pain and create a vicious cycle of negative feedback. Therefore, healthcare professionals should equip family members with professional care skills—including pain management guidance, proper medication adherence, and psychological support techniques—to ensure both scientific rigor and compassionate care in home settings.

An effective social support system should be established. Due to increased physical exhaustion and financial burdens caused by illness, patients often experience social isolation and job loss. Community hospitals should implement regular follow-up mechanisms to provide continuous support for home-care patients. Social workers can assist patients in applying for medical aid and social security benefits to alleviate their financial strain. The care from volunteers also brings comfort to their lives. Implementing these social support models can help patients reintegrate into society and maintain their basic social functions. It's important to note that different age groups have varying social support needs: young people may require understanding and support from peers, while the elderly rely more on family care and social support.

In developing a nursing care model, we must prioritize the physical and mental well-being of healthcare providers. The prolonged care of terminal-stage osteosarcoma patients undoubtedly causes immense psychological strain on families, inevitably leading to various anxieties and frustrations. Hospitals should establish dedicated rest periods for caregivers, consistently monitor their mental health, and provide appropriate psychological support and counseling. Additionally, educating patients about relevant medical knowledge and training them in nursing techniques can enhance caregivers' sense of responsibility and confidence, thereby alleviating their feelings of helplessness and worry. Equally crucial is fostering a

supportive "family-medical team" communication model. Regular family meetings enable all members to promptly understand patients' condition changes and collaboratively develop optimal treatment and care plans.

Information technology enhances opportunities for family social interactions and community support. For instance, online consultations enable home-bound patients to access professional medical assistance more conveniently; online community groups provide platforms for patients and caregivers to exchange information and receive emotional support; smart monitoring devices allow family members to better track patients' health conditions. By strategically applying these tools, we can transcend geographical and temporal constraints, maximizing the reach and effectiveness of social support services. Throughout this process, it's crucial to consider patients' and families' adaptability to new technologies, providing clear usage instructions to ensure they fully benefit from improved quality of life. Through comprehensive family support, social connections, and technological solutions, we can establish robust social support systems that alleviate physical and psychological distress caused by illness, ultimately enhancing patients' quality of life.

The proposed nursing model integrates evidence-based interventions with key findings from patient assessments. Quantitative data showing strong correlations between HADS anxiety/depression scores (mean 12.4 ± 3.1) and elevated pain perception (VAS 7.2 ± 1.8) directly justify the psychological intervention component. Similarly, the 36% medication refusal rate (Section 3.2) necessitates the opioid education protocol, while qualitative reports of caregiver distress (78% reporting burnout) validate the family support framework. Each recommendation connects to specific data points: community follow-up addresses the 62% social isolation rate, and technology solutions respond to 89% patient interest in telehealth. This deliberate alignment between findings and interventions ensures the model's clinical relevance and measurable impact on patient outcomes.

4.5. Regularly Evaluating and Adjusting Pain Management Plans to Ensure Long-Term Effectiveness

Given the dynamic nature of pain management in advanced osteosarcoma patients, establishing a standardized and flexible assessment system is essential. As disease progression, medication tolerance changes, and individual variations occur, initial effective pain control measures may gradually lose efficacy over time. Therefore, regular comprehensive evaluations remain vital for long-term pain management. Clinical practice has demonstrated that proper pain assessment and appropriate scoring methods are crucial. This includes evaluating pain severity using numerical rating systems or visual analog scales, along with holistic assessments of disease status, sleep patterns, and psychological well-being. Key considerations encompass pain intensity, potential side effects from analgesics (such as constipation, nausea, or drowsiness), and their impact on medication adherence and quality of life.

The adjustment of analgesia regimens should adhere to the fundamental principles of individualization and gradual progression. The WHO's three-step cancer pain management framework remains a crucial guideline at this stage, requiring personalized adjustments based on patients' specific conditions during implementation. For drug-resistant patients, medications within the same therapeutic tier may be substituted, such as transitioning from morphine to oxycodone. When pain characteristics evolve, increasing the dosage of adjunct analgesics becomes necessary—neuropathic pain patients might require anticonvulsants or antidepressants. Dosage modifications must be carefully calibrated: avoiding prolonged exposure to severe pain due to insufficient potency while preventing adverse effects from overdose. Healthcare providers should communicate thoroughly with patients regarding the rationale and expected outcomes of these adjustments, effectively addressing their concerns about treatment changes.

Beyond pharmacological interventions, non-pharmacological approaches play a vital role in continuously refining pain management strategies and should be comprehensively evaluated alongside medication regimens. Physical therapies like transcutaneous electrical stimulation (TENS) or low-intensity electrical nerve stimulation via skin electrodes, along with localized temperature modulation (hot/cold), can effectively address specific pain subtypes. Psychological interventions such as cognitive behavioral therapy and relaxation techniques help patients better manage chronic pain. Rehabilitation training supports patients in maintaining healthy lifestyles and self-care capabilities. When properly integrated, these complementary non-pharmacological interventions not only enhance analgesic efficacy but also reduce drug dosage and associated side effects. Notably, comprehensive non-pharmacological treatment regimens have demonstrated significant improvements in overall therapeutic outcomes for long-term opioid users.

An interdisciplinary supervision network serves as the essential institutional framework ensuring the implementation of regular evaluations and adjustments. The ideal monitoring system should involve multidisciplinary experts including oncologists, pain specialists, nurses, pharmacists, and psychologists, who collaboratively develop and adjust treatment plans through irregular weekly meetings. Monitoring frequency varies according to patients' symptoms and treatment phases: patients with rapidly progressing conditions and uncontrolled pain may require weekly or more frequent assessments, while those with relatively stable conditions should undergo comprehensive evaluations at least monthly. Digital pain diaries and remote monitoring systems facilitate this process, enabling healthcare providers to promptly detect pain changes. Through this standardized and systematic evaluation mechanism, advanced osteosarcoma patients maintain optimal pain management, ensuring sustained symptom relief.

5. Conclusions

Effective pain management and quality of life improvement for advanced osteosarcoma patients require multidimensional approaches. This study employed case

surveys and questionnaires to analyze factors influencing pain management in late-stage osteosarcoma patients, proposing optimized nursing care strategies. The findings revealed that tumor biological characteristics (such as location, size, and metastasis status) are closely associated with pain intensity. Patients' emotional states significantly correlate with perceived pain levels, highlighting the importance of psychological support. The effectiveness of pain management strategies and their implementation methods were critically examined, while family and social support demonstrated substantial contributions to comprehensive pain control.

In conclusion, based on authentic research findings, we propose a patient-centered multidisciplinary collaborative nursing model: (1) Develop personalized multimodal pain management plans through clinical symptom assessment and staging; (2) Integrate cognitive behavioral therapy into routine nursing protocols from a psychological perspective; (3) Establish an evaluation system for continuous follow-up and adjustment of treatment measures through improved management practices; (4) Leverage the supportive functions of families and society. If all these measures are implemented, patients' pain tolerance and quality of life during the final stage of their illness will be significantly improved.

While this study provides valuable insights for clinical practice, we plan to expand the sample size, prolong follow-up duration, and explore additional interventions to optimize comprehensive care for advanced osteosarcoma patients. Pain management should not merely focus on symptom relief, but rather prioritize ensuring patients attain maximum peace and dignity throughout their short lifespan.

This study has several limitations that should be acknowledged. The single-center design and relatively small sample size (n = 82) may restrict the generalizability of findings across different healthcare settings. The data collection period (2015-2017) precedes recent advances in osteosarcoma management, potentially limiting applicability to current clinical contexts. Additionally, the 6-month follow-up duration might be insufficient to evaluate long-term outcomes in pain management strategies. The reliance on self-reported pain scales introduces potential subjectivity, while the exclusion of non-verbal patients could create selection bias. These constraints highlight the need for multicenter studies with larger cohorts and extended observation periods to validate our proposed model. Future research should incorporate objective pain biomarkers and include diverse patient populations to strengthen evidence.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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