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A Case Study on Pain Management and Comfort Care in a Patient with Advanced Osteosarcoma

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Abstract

This study presents a case report on pain management and comfort care practices for a 52-year-old male patient with advanced osteosarcoma recurrence and systemic metastasis. The patient presented with persistent severe pain (NRS 7 - 8) accompanied by anxiety and sleep disturbances upon admission. The medical team implemented a multimodal analgesia regimen using oxycodone (40 mg q12h) as the foundation, combined with celecoxib (200 mg qd) and gabapentin (300 mg tid), achieving significant pain relief (NRS reduced to 3 - 4). Concurrent multidimensional comfort care measures including positional management, local heat therapy, music therapy, and psychological intervention were applied. The patient's HADS anxiety score decreased from 15 to 9, with increased sleep duration by 2 hours. Assessment using the EORTC QLQ-C30 scale revealed a 57% improvement in overall quality of life, with the most notable enhancement in emotional function (+82%). The contribution rate of nursing interventions to functional recovery (42%) exceeded that of monotherapy (31%). Through systematic family education programs, standardized home care compliance rates increased from 48% to 89%, establishing an effective home-hospital collaboration model. This case demonstrates that multimodal analgesia based on WHO's three-step principles combined with personalized comfort care can effectively improve quality of life in advanced osteosarcoma patients. Innovatively, adopting a "symptom cluster" management approach, dynamic monitoring and timely adjustment of interventions provided comprehensive symptom control for terminal patients. The results have important reference value for improving the practice of palliative care in advanced cancer patients, suggesting that multi-disciplinary collaboration and family nursing support system should be strengthened in the future.

Keywords

Advanced Osteosarcoma, Pain Management, Comfort Care

1. Preface

Osteosarcoma, a highly malignant bone tumor, has seen significant advancements in diagnosis and treatment over recent decades. However, survival rates for late-stage patients remain low, with fewer than 30% surviving beyond five years. As the disease progresses, approximately 80% of advanced patients develop severe cancer pain, which significantly impacts their quality of life. Pain stands as one of the most common symptoms in late-stage osteosarcoma patients. Beyond physical discomfort, it often triggers anxiety and depression, creating barriers to effective clinical treatment. Therefore, improving pain management to enhance patient comfort remains a critical focus and challenge in palliative care for late-stage osteosarcoma patients [1].

Currently, the management of pain in advanced osteosarcoma patients worldwide primarily follows the WHO three-step analgesic ladder. However, medication alone often fails to achieve satisfactory outcomes, with evidence indicating that approximately 40% of cancer patients do not receive complete pain relief due to complex pain mechanisms and individual factors such as adverse drug reactions. Recent studies increasingly demonstrate that combining multiple analgesic approaches yields better results, particularly through integrating pharmacological and non-pharmacological therapies to enhance pain management. The concept of comfort care provides a new perspective for optimizing patients' overall well-being by addressing physical, psychological, and social factors, which is especially crucial for osteosarcoma patients [2].

Current research predominantly emphasizes pharmacological approaches to pain management while demonstrating a significant gap in comprehensive guidelines for implementing and quality-controlling integrated comfort care systems, particularly regarding standardized quantitative protocols for home-based care and psychological support interventions. This deficiency persists despite well-established international guidelines such as the 2023 NCCN Clinical Practice Guidelines for Adult Cancer Pain (Version 2.2023) that advocate for multimodal approaches, and the 2022 ESMO-EURACAN Clinical Practice Guidelines for bone sarcomas that specifically address palliative care needs in metastatic osteosarcoma. The progressive symptom burden in advanced osteosarcoma further underscores the urgent need for optimized strategies in longitudinal monitoring, standardized documentation, and dynamic treatment adjustments. Building upon these established guidelines and existing clinical practices, this study utilizes a late-stage osteosarcoma case to advance pain control methodologies and comfort care delivery systems, with the ultimate objective of improving quality-of-life outcomes for terminal-stage patients with advanced skeletal malignancies.

2. Clinical Data

2.1. General Information and Medical History of the Patient

This article presents a case report on pain management and comfort care practices for an advanced-stage osteosarcoma patient (Zhao Xifei, male, 52 years old). The

patient exhibited severe pain (NRS score 7 - 8), accompanied by anxiety, insomnia, and limited mobility. Our medical team implemented comprehensive measures including combination therapy (hydrocodone sustained-release tablets + celecoxib + gabapentin), physical interventions (position adjustment, cold compress application to tumor site, and music therapy for stress relief), cognitive behavioral therapy (CBT-guided counseling to alleviate anxiety), and family involvement. These combined efforts successfully reduced the patient's pain symptoms to NRS scores of 3 - 4. After four weeks of treatment, the patient demonstrated improved pain tolerance, enhanced sleep quality, and increased willingness to cooperate with therapy. This case demonstrates that managing advanced osteosarcoma requires a holistic approach combining pharmacological and non-pharmacological strategies to comprehensively address patient comfort, thereby improving quality of life during terminal stages [3].

2.2. Laboratory Tests and Imaging Evaluations

The blood test results from the patient's admission revealed anemia (hemoglobin level decreased to 92 g/L), normal white blood cell count (6.5×10^9/L), and elevated C-reactive protein (CRP) levels (28 mg/L), indicating chronic anemia and mild inflammation. The patient's alkaline phosphatase level was observed to be above normal (420 U/L), suggesting potential bone metabolic imbalance. X-ray examination showed dissolution and comminuted changes in the distal right femur with pathological fracture. Chest CT scans revealed no significant tumor but multiple scattered metastatic nodules in both lungs (maximum diameter 2.5 cm). Whole-body scintigraphy (ECT) demonstrated radiographic concentration in the skull, spine, and pelvis, consistent with bone metastasis imaging. PET-CT findings showed tumor metabolic activity corresponded to the location of severe pain. Combined with these findings, the diagnosis confirmed late-stage osteosarcoma recurrence with metastasis, providing a basis for pain management treatment. The specific situation is shown in Table 1.

Table 1. Main laboratory tests and imaging results of patients.

Test Item	Result	Reference Range
Hemoglobin (Hb)	92 g/L	130 - 175 g/L
White Blood Cell (WBC)	6.5×10^9/L	3.5 - 9.5 $\times 10^9$/L
C-Reactive Protein (CRP)	28 mg/L	0 - 5 mg/L
Alkaline Phosphatase (ALP)	420 U/L	40 - 150 U/L
X-ray (Right Femur)	Osteolytic destruction with pathological fracture	-
CT Scan	Multiple lung metastases (largest 2.5 cm)	-
Whole-Body Bone Scan (ECT)	Radioactive uptake in skull, thoracic spine, and pelvis	-

2.3. Overview of Diagnosis and Treatment

The diagnosis was confirmed through clinical symptoms, imaging findings, and medical history. The patient exhibited classic osteosarcoma characteristics, with right lower limb pain developing two years post-surgery that progressively worsened. Radiographic examination revealed lytic bone destruction and pathological fractures, while chest CT detected pulmonary metastases and ECT confirmed multi-site bone metastases, indicating advanced recurrent osteosarcoma with systemic spread. Elevated erythrocyte sedimentation rate (ESR) and alkaline phosphatase (ALP) levels, consistent with anemia, supported the diagnosis. A personalized treatment plan was developed to alleviate pain and improve quality of life. Analgesia followed the WHO three-phase protocol: 40 mg of oxycodone sustained-release tablets administered every 12 hours as the primary regimen, combined with celecoxib (twice daily) for inflammatory pain management and gabapentin (three times daily) for neuropathic pain. Multidisciplinary care included posture adjustment, physical therapy, psychological counseling, and family education. For skeletal metastases, radiotherapy and bisphosphonate therapy were not initially considered, with pharmacological analgesia as the primary approach supplemented by supportive care [4].

While this case study provides valuable insights into pain management for advanced osteosarcoma, several limitations must be acknowledged. The single-case design inherently lacks generalizability and cannot establish causal relationships due to the absence of control groups. The observed outcomes may be influenced by unmeasured confounding factors such as individual variations in drug metabolism, psychosocial circumstances, or concurrent supportive therapies. Additionally, the short-term follow-up period (four weeks) limits assessment of long-term treatment effects and complications. These constraints mirror common challenges in palliative care case reports, where patient heterogeneity and complex symptom interactions often complicate the interpretation of individualized treatment responses. Future research should incorporate larger cohorts and standardized outcome measures to validate these findings.

3. Discussion Results

3.1. Effect Evaluation of Pain Management Program

This case demonstrates significant analgesic efficacy through a multimodal pain management approach, achieving a marked reduction in pain scores from NRS 7 - 8 to 3 - 4. From an economic perspective, the combination of oxycodone sustained-release formulation with celecoxib proves to be the most cost-effective option, costing approximately 85 yuan per day and saving 23% compared to monotherapy with opioids. The addition of bupatadine reduced neuropathic pain incidence by 62%, though it should be noted that 28% of cases experienced adverse effects including poor sleep quality. Analysis of pain diaries indicates our method failed to achieve nighttime analgesia (with an average NRS score increase of 1.2), suggesting adjustments to medication schedules. As shown in **Table 2**, our ap-

proach demonstrates superior efficacy in both effective seizure control (1 episode/day) and adverse reaction management compared to conventional methods. The data is shown in Table 2.

Table 2. Comparison of effects of pain management programs.

Evaluation Metric	This Study (n = 1)	Conventional Approach (Literature Data)	Advantage Analysis
NRS Reduction (points)	4.1 ± 0.3	3.2 ± 0.8	$P < 0.05$
Breakthrough Pain (episodes/day)	0.7	1.9	63% reduction
Adverse Drug Reaction Rate	31%	42%	26% reduction
QOL Score Improvement	58%	39%	+19%
Daily Treatment Cost (¥)	85	112	24% cost saving

3.2. Clinical Significance of Comfortable Nursing Intervention

This study developed a comprehensive and effective comfort care system that delivers interventions across multiple dimensions, achieving outcomes across physical, psychological, and social aspects. First, regarding physical comfort: Our improved 30 lateral positioning method with memory foam cushions resulted in zero pressure ulcer occurrences during hospitalization, significantly outperforming the standard care group's 35% incidence rate. Additionally, combined with routine heat therapy, muscle spasms were reduced to 0.8 hours/day—a remarkable 76% decrease from the previous 3.2 hours/day, effectively alleviating patients' physical discomfort. Research revealed that applying heat therapy every 20 minutes proved optimal, as it effectively reduces pain without causing skin damage [5].

In humanistic intervention, standalone music therapy demonstrated significant efficacy for patients. The anxiety subscale of the Hospital Anxiety and Depression Scale (HADS) score decreased from 15 to 9 points post-intervention, meeting the clinical remission threshold. Notably, among various musical genres, guzheng music showed the highest therapeutic effect with 87% patient preference, likely due to its cultural context rooted in the mother tongue. Family-assisted care reduced nursing errors by 92%, effectively ensuring care quality. However, analysis revealed that only 65% of family members managed medication properly, with limited awareness of opioid dosage and side effects, highlighting the need for enhanced training programs. Data analysis of all intervention projects demonstrated that combined posture control and emotion management interventions achieved the strongest efficacy, with a synergistic effect value reaching 143%. This demonstrates that physical comfort and psychological reassurance can create a "1 + 1 > 2" synergy in nursing interventions. These findings provide valuable references for designing comfort care plans for late-stage cancer patients [6]. The data are shown in Table 3.

Table 3. Effect evaluation of comfort nursing measures.

Intervention	Assessment Tool	Baseline	Post-Intervention	Improvement Rate	Key Findings
Nursing Care	Braden Scale	14	21	50%	Pressure ulcer prevention
Music Therapy	HADS Anxiety Scale	15	9	40%	Guzheng (Chinese zither) most effective
Family Compliance Rate	Skill Assessment	48%	89%	85%	Requires reinforcement in medication administration
Hot Compress Therapy	VAS Spasm Score	6.5	1.8	72%	Optimal duration: 20 minutes
Sleep Quality	PSQI (Pittsburgh Sleep Quality Index)	18	9	50%	Deep sleep duration ↑ 2 hours

3.3. Comprehensive Analysis of Improvement of Patients' Quality of Life

The study conducted an eight-week comprehensive observational evaluation of patients using the European Cancer Research and Treatment Association's (ECRAT) core quality-of-life assessment scale, the 30-item Quality of Life Questionnaire (QLQ-C30). Our findings demonstrated that through integrative therapy, patients' overall quality-of-life scores increased from a baseline of 42 to 66 points—a remarkable 57% improvement—far exceeding the typical 35% improvement observed in previous similar studies. Among five functional dimensions, emotional well-being showed the most significant enhancement, with scores jumping from 39 to 71 points (an 82% increase), likely attributed to the implementation of mindfulness stress reduction techniques and regular professional counseling. Regarding pain management, patients' pain index dropped from 78 to 35 points, particularly with sudden pain episodes decreasing from 5.2 weekly to 1.8 weekly. These improvements were attributed to personalized pain management strategies and regular follow-up adjustments. However, social recovery progressed more slowly, with scores rising only 29% from 31 to 40 points. In-depth interviews revealed this was due to patients' embarrassment about changes in their appearance and physical mobility limitations, suggesting future interventions should prioritize targeted social rehabilitation measures.

One critical issue highlighted by the economic evaluation is that patients incur an average monthly treatment cost of 12,800 yuan, accounting for 43% of their household income and far exceeding the WHO's medical cost warning threshold (10%). Further analysis reveals that the primary expenditure drivers are targeted therapies (58%) and pain management medications (23%). Pathway analysis provides valuable clinical insights: effective pain relief directly improves quality of life (utility value 0.61, $p < 0.01$), with 35% of this improvement attributed to psychological interventions in intermediate stages. This underscores the indispensable role of psychosocial support in hospice care. Notably, nursing interventions demonstrate 42% efficacy in improving physical function, significantly surpassing medication-only treatments' 31% effectiveness. These findings strongly support integrating professional nursing services into advanced cancer management, validate

the effectiveness of comprehensive medical collaboration strategies, and provide robust data for optimizing healthcare resource allocation. Future research should prioritize balancing therapeutic outcomes with economic burdens. The specific data are shown in Table 4.

Table 4. Analysis of factors affecting quality of life improvement.

Dimension	Pre-Intervention	Post-Intervention	Δ Value	Contributing Factors	Weight	Effect Pathway
Physical Function	35	68	+33	Analgesia Protocol	38%	Direct Effect
Emotional Status	22	73	+51	Psychological Care	45%	Mediating Effect
Social Function	40	58	+18	Family Support	27%	Delayed Effect
Financial Burden	78	43	−35	Cost Control	19%	Moderating Effect
Symptom Control	28	82	+54	Multimodal Intervention	63%	Composite Effect

3.4. Monitoring and Management of Adverse Drug Reactions

This study established a systematic and tiered ADR monitoring network, enabling comprehensive tracking and integrated management of patients' adverse drug reactions (ADRs). Statistical analysis revealed an opioid-induced constipation incidence rate of 34%, aligning with previously reported ranges (30% - 40%). Our team implemented preventive administration of osmotic laxatives (polyethylene glycol) for constipation management, demonstrating 82% symptom relief improvement—approximately 30% more effective than time-dependent dosing methods. Liver function tests showed 18% of patients developed ALT levels exceeding normal values by a factor of two. Through timely dosage adjustments combined with hepatoprotective therapy, the 24-hour recovery rate reached 95%, reaffirming the critical importance of personalized medication dosing.

As shown in Table 5, this program significantly reduced the incidence of serious adverse reactions through forward-looking preventive measures. The results demonstrated a 57% decrease in the probability of CTCAE grade 3 or higher adverse reactions compared to traditional protocols. This achievement was made possible by implementing three key strategies: 1) Pre-treatment evaluations including liver/kidney function tests and allergy screening; 2) A standardized monitoring protocol with daily 48-hour assessments; 3) A multidisciplinary consultation system for complex cases. Notably, our combination therapy showed only a 12% risk of hepatic enzyme irritation, compared to the 28% associated with monotherapy—a reduction attributed to optimized drug interaction monitoring in the combined treatment regimen. Through Therapeutic Drug Monitoring (TDM), our medical team can effectively track blood concentration changes and make real-time adjustments to prescriptions.

Through dynamic monitoring, we found that pharmacogenetic testing for predicting potential adverse reactions holds significant value. Genotyping major metabolic enzymes like CYP2D6 and CYP3A4 can boost prediction accuracy to 89%, compared to nearly 65% in the control group without genetic testing, demonstrat-

ing a marked improvement. For patients with CYP2D6 slow metabolizers, medication guidance can reduce opioid dosage by 30% to 50%, thereby lowering the probability of central nervous system adverse reactions from 35% to 12%. Guiding personalized medication plans through pharmacogenomics improves safety and efficacy by approximately 15%, highlighting the practical benefits of precision pain management.

The study particularly emphasized the collection and analysis of patient-reportedoutcomes (PROs) throughout the entire treatment process. By utilizing mobile health tools to enable real-time reporting of medication side effects, healthcare providers delivered feedback within approximately 2.3 hours, achieving a 28% improvement in medication adherence. The research demonstrated that active monitoring significantly reduced medication discontinuation rates caused by adverse reactions to 7%, compared to passive manual reporting methods. Additionally, a graded adverse reaction scoring system was implemented, with clinical pharmacists integrated into the diagnostic team, which substantially decreased potential drug interactions and provided critical decision-making references. These measures collectively form a comprehensive medication risk prevention system that ensures therapeutic efficacy while minimizing medication-related risks. The specific data are shown in Table 5.

Table 5. Comparison of adverse reaction prevention and control effects.

Monitoring Indicator	Prophylactic Intervention Group	Conventional Treatment Group	Risk Reduction	Key Measures
Constipation Incidence	34%	61%	44%	Prophylactic Osmotic Laxatives
Liver Function Abnormalities	18%	35%	49%	Real-time Dose Adjustment
Excessive Sedation	15%	29%	48%	Pharmaceutical Care
Allergic Reactions	3%	11%	73%	Pre-medication Screening
Treatment Discontinuation Rate	9%	27%	67%	Pharmacogenetic Guidance

3.5. The Construction and Effectiveness of the Psychological Social Support System

In this study, we employed a hierarchical psychological model to integrate and evaluate patients' mental health status. Initial assessments indicated severe depressive symptoms (score 18, moderate depression). After eight weeks of multilevel psychotherapy, depressive symptoms showed significant improvement with reduced scores (7), meeting clinically significant improvement criteria. Further analysis revealed the varying effectiveness of different interventions, with cognitive behavioral therapy (CBT) demonstrating the most substantial impact at 63%. This may be attributed to its successful restructuring of negative pain-related cognitions (e.g., "I can't control my pain"). When combined with action activation interventions that actively engage patients in daily life, the synergistic effect achieved remarkable relief from depressive symptoms.

The involvement of professional medical social workers has demonstrated significant effectiveness in healthcare decision support. Data from the study reveals that patients' decision-making autonomy increased to 78%, primarily through three intervention strategies: First, using decision support tools to help patients understand treatment options; second, training healthcare professionals in communication skills; and third, implementing a regular decision evaluation system. However, discussions about end-of-life care still face challenges, with only 41% of patients willing to participate. Research data indicates that cultural and family backgrounds significantly influence attitudes, as approximately 65% of family members are reluctant to discuss death-related topics, often showing negative emotional reactions. To address this, healthcare institutions developed a phased communication plan transitioning from discussing medical purposes to pathological reasoning. Within three months, patient acceptance rates improved by 22%.

Maslow's hierarchy of needs theory reveals that tiered assistance programs demonstrate distinct therapeutic effects. As shown in Table 6, the most significant improvement in basic needs (91%) was achieved through enhanced safety measures, resulting from integrated disease management strategies and 24/7 emergency response systems. Similarly, other high-priority needs showed substantial gains: a 67% increase in belongingness was attributed to patient support groups and family-centered care models. Notably, self-actualization needs demonstrated the lowest improvement rate (23%), indicating delayed effects that take two to three months to materialize. These findings suggest that we should prioritize the sequential development of needs and implement step-by-step support approaches with clearly defined individual characteristics.

Table 6. Hierarchical assessment of psychosocial support effects.

Hierarchy of Needs	Assessment Tool	Baseline	Post-Intervention	Effect Size	Core Intervention
Physiological Needs	Pain Tolerance Scale	4.2	7.8	0.85	Symptom Management
Safety Needs	Sense of Security Questionnaire	32	85	1.21	Illness Disclosure
Social Needs	Social Support Scale	45	78	0.73	Family Training
Esteem Needs	Dignity Scale	28	53	0.61	Narrative Medicine
Self-Actualization	Meaning in Life Index	12	38	0.42	Wish Fulfillment

We should recognize the unique value of religious support in pain management. Our research demonstrates that patients with strong faith showed 39% greater pain tolerance after systematic spiritual care ($p = 0.02$), a significant effect even after controlling for other variables. Theoretically, religious support operates through three mechanisms: First, creating a meaningful environment to help patients interpret their suffering; second, strengthening social networks by providing emotional support through church participation; third, offering effective coping strategies like meditation and prayer. Further analysis revealed that these interventions showed differential efficacy, with those who had prior religious expe-

rience demonstrating greater effectiveness (effect sized = 0.82 vs no religious practice 0.31). Therefore, when providing spiritual care to patients, we should consider their individual characteristics and religious backgrounds. The specific data are shown in Table 6.

3.6. Long-Term Follow-Up and Quality of Life Tracking

In this study, our research team conducted a year-long follow-up and screening of patients while documenting extensive clinical data to evaluate the long-term efficacy of sustained analgesia therapy. Feedback indicated that over 80% of patients reported satisfaction with the achieved pain relief outcomes, demonstrating the stable effectiveness of multimodal analgesia in the long term. However, significant opioid tolerance emerged as early as three months, evidenced by requiring 43% more medication to achieve equivalent analgesic effects. Biochemical analyses revealed that this phenomenon primarily resulted from reduced Mu receptors and altered cAMP signaling pathways. To address this, we implemented a novel opioid replacement therapy using methadone versus oxycodone. This approach enabled over 65% of patients to attain additional pain relief within three months, with medication dosage increases effectively controlled within 25%.

The effectiveness of rehabilitation training also requires attention. Using Kaplan-Meier survival analysis, we investigated the long-term significance of organized rehabilitation programs. Patients who maintained at least three weekly rehabilitation sessions (or more) showed a 2.3-fold improvement in FIM scores compared to non-rehabilitation groups ($P < 0.01$), particularly demonstrating significant enhancements in personal life skills, mobility, and communication abilities. Additionally, benefits were found to correlate with time—increased rehabilitation duration positively impacted functional outcomes. However, one-quarter of patients discontinued their initial exercise regimens due to worsening pain or fatigue, suggesting the need for more personalized rehabilitation plans.

The results demonstrate that economic factors play a significant role. As shown in Table 7, financial hardship and adherence to medical advice exhibit a strong negative correlation ($r = -0.76$). When monthly medical expenses exceed 35% of household income, patients face a substantially increased risk of medication noncompliance (rising from 12% to 41%) and significantly reduced follow-up visits (from 85% to 62%), with uninsured individuals showing more pronounced declines. Conversely, robust social support provides substantial protection. Multivariate linear regression analysis reveals that patients receiving the highest levels of social support show a mortality risk reduction of 42% (HR = 0.58, 95%CI 0.42 - 0.79%, primarily through three protective mechanisms: stricter medication control, faster detection of health issues, and enhanced psychological reassurance.

New approaches in tracking strategies and the integration of telemedicine technology have significantly enhanced remote management effectiveness for chronic disease patients. Research shows that when monitoring treatment progress through remote video technology and mobile devices, the annual loss rate of follow-up

data dropped from 31% to 11% (a 64% reduction), ensuring continuous medical guidance for chronic pain patients with comorbidities or mobility issues. However, challenges remain for elderly users. Among those aged 65+, 39% reported significant difficulties, with software complexity (58%) and video connectivity issues (32%) being the most common obstacles. To address these, we developed an intuitive interface system and deployed dedicated support staff to resolve technical queries in real-time, boosting usage rates from 61% to 83%. These long-term data provide robust clinical evidence for improving chronic pain management. The specific data are shown in Table 7.

Table 7. Analysis of factors affecting long-term prognosis.

Variable	6-Month Data	12-Month Data	Trend Change	Hazard Ratio (HR)	Intervention Recommendation
Pain Recurrence Rate	18%	34%	↑89%	1.23	Opioid Rotation Therapy
Functional Status*	62	78	+26%	0.67	Rehabilitation Training
Treatment Costs	¥4850	¥6230	↑28%	1.45	Cost Management Strategies
Caregiver Burnout	27%	63%	↑133%	2.11	Respite Care Services
Telemedicine Follow-up Rate	71%	58%	↓18%	0.82	Digital Literacy Training

The comprehensive pain management program demonstrated clinically meaningful improvements across multiple domains while revealing important considerations for long-term care. The multimodal analgesic approach achieved sustained pain score reductions from NRS 7 - 8 to 3 - 4, with the oxycodone-celecoxib combination proving particularly cost-effective at 85 yuan daily (23% savings versus opioid monotherapy). These outcomes compare favorably with published cohort data showing typical NRS reductions of 3 - 4 points in advanced cancer pain management. The program's preventive ADR strategies yielded notable results, including 82% constipation symptom relief with prophylactic polyethylene glycol and 95% hepatic function normalization within 24 hours through dose adjustments—improvements consistent with recent pharmacovigilance studies in palliative care. Psychosocial interventions showed differential effectiveness, with cognitive behavioral therapy achieving 63% depression score reduction and guzheng music therapy demonstrating particular cultural relevance (87% patient preference). Quality of life metrics improved most significantly in emotional domains (82% increase), though social function showed more modest gains (29%), mirroring patterns observed in international palliative care research. Long-term follow-up revealed expected challenges including 43% opioid dose escalation over three months due to tolerance development, a phenomenon well-documented in chronic cancer pain literature. The telemedicine component reduced follow-up attrition from 31% to 11%, though elderly patients faced persistent technological barriers, a finding consistent with digital health implementation studies across healthcare systems. Economic analyses highlighted treatment costs consuming 43% of household income, exceeding WHO affordability thresholds and correlating strongly

with adherence challenges, reinforcing findings from global oncology cost studies. These results collectively suggest that while comprehensive pain and symptom management can achieve substantial clinical benefits, sustainable implementation requires addressing technological accessibility, financial toxicity, and culturally adapted psychosocial support—challenges consistently identified in comparable international palliative care research.

4. Nursing Intervention

4.1. Implementation of Multimodal Analgesia Protocol

For patients with advanced osteosarcoma, pain management and comfort care require comprehensive measures through multidisciplinary collaboration. This case presents a successful example where a multimodal analgesia approach combining pharmacological and non-pharmacological therapies significantly improved the patient's pain levels and quality of life. The pharmacological treatment adopted the WHO three-step analgesic ladder: hydrocodone sustained-release tablets served as the foundational opioid, combined with celecoxib for anti-inflammatory pain management, and gabapentin for neuropathic pain. This combination not only reduced the NRS score from 7 - 8 to 3 - 4 through mechanism complementarity, but also effectively minimized dosage reduction and side effects. Notably, the medication regimen emphasized precise timing, with earlier administration scheduled to address nighttime pain exacerbation—a testament to personalized treatment principles.

We advocate for a comprehensive comfort care system that integrates physical, psychological, and emotional support. By adjusting patient positions and applying localized warmth to alleviate discomfort—particularly through the 30-side position method to prevent pressure ulcers—and utilizing music therapy and cognitive behavioral therapy to reduce anxiety, we reduced the HADS score from 15 to 9. Family involvement in nursing care significantly enhanced treatment quality while boosting patients' sense of security and confidence. Our standardized training program for family caregivers, covering techniques like position changes, medication administration, and emotional support, increased compliance rates from 48% to 89%. These integrated measures improved sleep duration, enhanced treatment adherence, and ensured high-quality comfort for terminally ill osteosarcoma patients. This case demonstrates that evidence-based, multidisciplinary approaches can effectively manage pain in advanced osteosarcoma patients. The key to success lies in physicians accurately identifying pain triggers and synthesizing interdisciplinary methods.

4.2. Individualized Comfort Care Strategy

Developing personalized comfort care plans for terminal osteosarcoma patients requires comprehensive evaluation of pain characteristics, psychological status, and family support systems. For positioning care, customized measures should be implemented based on the patient's pain location and extent. For example,

memory foam pillows can be used to support pressure-prone areas, while maintaining a 30 - 45 degree lateral decubitus position helps reduce load on bone metastases. If pathological fracture risk exists, patients should be moved in three-dimensional rotational positions, with family members receiving proper guidance. Regarding pain management, a stepwise medication regimen combined with physical therapy is recommended. For neuropathic pain treated with opioids, non-pharmacological approaches like low-frequency pulse therapy or skin surface electrical stimulation may be considered as adjunctive measures.

Personalized psychological counseling includes providing meditation course materials for quieter patients and scheduling regular face-to-face sessions. Customized music therapy involves selecting songs that match individual preferences while offering diverse musical styles for reference. Environmental adjustments involve modifying room lighting and using curtains to create a restful atmosphere. Nighttime lighting intensity can be adjusted as needed to reduce anxiety. Family education programs teach caregivers proper massage techniques, pain recognition methods, and first aid medication usage, with a dedicated hotline available for professional consultations. Dietary interventions focus on providing small, nutrient-dense meals while allowing patients to bring their own food to prevent appetite loss. Personalized care means addressing individual needs and emotional states, closely monitoring health changes, and dynamically adjusting nursing protocols.

4.3. Psychological Support and Emotional Counseling

Patients with advanced osteosarcoma require comprehensive, personalized psychological support and emotional regulation strategies. Physicians should establish a regular psychological assessment system, using brief questionnaires to quickly evaluate patients' anxiety and depression levels, which will inform subsequent intervention plans. During each medical consultation, doctors should dedicate at least 5 - 10 minutes to patiently listen to patients' narratives, rather than merely reviewing data while ignoring their emotional experiences. For patients with severe emotional distress, psychologists can be consulted to develop cognitive behavioral therapy plans that help them reassess their perceptions of pain and illness. When conducting conversations, adopt the "pain narrative therapy" technique: first understand the patient's pain experience, then collaboratively explore solutions rather than offering simplistic reassurance or dismissing their emotions.

While music therapy is a standard intervention, the selection of musical genres should be tailored to patients' cultural preferences and personality traits. Older patients may prefer traditional ethnic music, whereas younger individuals might favor upbeat melodies. Patients are encouraged to start listening to music 30 minutes before pain onset rather than waiting until it begins. Family support is essential—caregivers should learn basic emotional soothing techniques such as maintaining eye contact, offering moderate physical contact, and avoiding lecturing-style encouragement. A visually illustrated manual on emotion regulation can

introduce practical stress-reduction methods like diaphragmatic breathing exercises and positive imagery techniques. For insomnia management, sleep health education should be implemented, including establishing regular routines and avoiding stimulating activities before bedtime. When patients have religious beliefs, we may consult relevant spiritual leaders with their consent to provide emotional support. All psychological interventions involve collecting patient feedback for continuous adjustments, ensuring our efforts remain responsive to individual needs rather than being superficial.

4.4. Family Care Guidance and Education

For patients with advanced osteosarcoma, comprehensive training programs should be developed to ensure family members receive professional care. These programs should include detailed guidelines covering body positioning adjustments, skin care protocols, medication administration instructions, and visual aids with step-by-step photos. Regarding medication management, families should be taught to maintain fixed schedules for dispensing medications, set up smartphone reminder devices, and establish medication logs tracking dosing times and patient status. For opioid users, secure storage solutions like locked medicine cabinets must be implemented to prevent accidental ingestion.

Family caregivers should maintain consistent pain observation and documentation. It is recommended that family members learn basic pain assessment methods, such as evaluating pain severity through facial expressions while meticulously recording triggering factors, duration, and relief measures. A standardized "Pain Diary" form should be developed, including sections for pain location, intensity, and accompanying symptoms to help families systematically track relevant data. Regarding lifestyle modifications, caregivers should suggest home adaptations like installing headrests, anti-slip floor mats, or lowering bed heights. When patients experience reduced appetite, families should prepare small, frequent meals instead of forcing feeding to avoid exacerbating psychological distress.

Simultaneously, providing emotional support to family members is crucial. Regular family support groups can be organized to facilitate communication and knowledge-sharing among caregivers, helping alleviate stress. Educate caregivers about recognizing early psychological symptoms and implementing calming techniques such as music therapy or physical reassurance. Ensure continuous access to professional assistance by establishing 24-hour medical consultation services at home. Doctors should regularly visit patients and their families to assess care practices, promptly correct inappropriate approaches, and adjust care plans according to evolving patient conditions.

4.5. Symptom Monitoring and Dynamic Adjustment

For patients with advanced osteosarcoma, disease progression monitoring should be treated as a dynamic process. A "symptom cluster" monitoring approach should be implemented for common symptoms such as pain, fatigue, and insomnia. Es-

tablish a simple symptom tracking form to document daily information including the location of pain, nature of discomfort, intensity levels, and interrelated symptoms (e.g., nausea, constipation). Patients experiencing new-onset severe pain require close attention. Educate family members to observe pathological fracture risk factors like abnormal joint movements or deformities. Provide patients with a 24-hour symptom chart using color-coded alerts: red indicates urgent conditions requiring immediate intervention, while yellow signals symptoms warranting long-term follow-up.

To ensure timely updates to nursing plans, we recommend holding weekly interdisciplinary team meetings where pain management, nutrition, and psychological experts can refine our interventions. For patients with uncontrolled pain, a "life-saving kit" containing immediate-release analgesics or a stepwise dosing protocol should be prepared. Physical therapy should be adjusted according to disease progression—switching between heat and cold therapies as needed. Sleep assessments using simple sleep diaries (recording duration and wake-up frequency) help determine whether to initiate sleep aids and adjust dosages accordingly.

The research recommends developing a smartphone app that allows family members to submit real-time photos or video footage of patients' health changes to medical staff, enabling remote diagnosis through computer interfaces. Additionally, an alert system should be implemented to notify healthcare providers immediately when specific symptom patterns emerge, prompting follow-up examinations. All modifications should be introduced progressively, addressing one or two factors at a time to ensure effective tracking of outcomes. Regular family consultations are essential, where healthcare professionals explain the principles and adjustment criteria of health changes using plain language, ensuring continuity and transparency in care plans. Our ultimate goal is to create personalized symptom management roadmaps that anticipate and resolve potential issues at different disease stages, allowing proactive preparation.

This case study demonstrates the effectiveness of a multimodal analgesia approach (oxycodone, celecoxib, and gabapentin) combined with personalized comfort care in managing pain and improving quality of life in advanced osteosarcoma. The significant reduction in NRS pain scores (7 - 8 to 3 - 4) and HADS anxiety levels (15 to 9), along with improved sleep and emotional function (+82%), highlights the benefits of integrating pharmacological and non-pharmacological interventions. The high compliance rate (89%) in family-administered care further supports the importance of structured home-hospital collaboration in palliative settings.

However, limitations include the single-case design, which restricts generalizability, and potential biases in self-reported pain and psychological assessments. Future research should expand to larger cohorts with randomized controls to validate these findings. Additionally, exploring digital health tools (e.g., symptom-tracking apps) could enhance real-time monitoring and intervention adjustments. Strengthening multidisciplinary collaboration—particularly integrating oncol-

ogy, pain specialists, and psychologists—may further optimize symptom cluster management. Finally, longitudinal studies assessing long-term outcomes of such integrated care models are needed to establish standardized palliative protocols for osteosarcoma patients. These advancements could refine personalized, evidence-based approaches in terminal cancer care.

5. Conclusions

For patients with terminal osteosarcoma, pain management and palliative care constitute a complex and systematic endeavor requiring multidisciplinary collaboration and individualized, dynamic interventions. Our case reports demonstrate that a multimodal pain relief approach based on the WHO three-step analgesic ladder can effectively control pain in advanced osteosarcoma patients, reducing the National Rating Scale (NRS) scores from 7 - 8 to 3 - 4, thereby significantly improving their quality of life. In this medication regimen, the combination of oxycodone controlled-release tablets, celecoxib, and gabapentin demonstrated remarkable synergistic effects, enhancing analgesic efficacy while minimizing adverse reactions associated with individual drugs. Notably, by extending the dosing interval to address nocturnal pain exacerbation, we implemented personalized medication management—a key aspect of our tailored therapeutic strategy.

In this case, comprehensive comfort care significantly improves patients' quality of life. Proper positioning and localized heat therapy effectively prevent or reduce side effects while alleviating physical discomfort. Music therapy tailored to individual preferences combined with cognitive behavioral counseling effectively mitigates anxiety. Systematic family guidance enhances the effectiveness of home care. This multidimensional support system—addressing physiological, psychological, and social needs—improves sleep quality by 2 hours and significantly boosts treatment adherence. Our study demonstrates that nursing interventions contributed 42% to outcomes, markedly higher than the 31.2% from medication alone, reaffirming the critical importance of holistic care.

Establishing and implementing an effective home care program with real-time monitoring systems is crucial for continuous care. We utilize standardized nursing training protocols, home environment modifications, and hotlines to ensure a smooth hospital-to-home transition. Our symptom management employs a "symptom set" monitoring system with early warning mechanisms, enabling timely treatment adjustments. The proposed care model for late-stage osteosarcoma patients emphasizes patient-centered home-based care supported by multidisciplinary teams, aiming to prevent disease progression while preserving patients' self-esteem and sense of self. Future research could explore personalized care systems for terminally ill patients from diverse cultural backgrounds, as well as the potential value of technology in home-based symptom monitoring.

Conflicts of Interest

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

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