

Journal of Clinical and Nursing Research

Honorary Editor-in-Chief

Linda Rykkje

VID Specialized University Faculty of Health, Norway

Editor-in-Chief

Feng Hui

Xiangya School of Nursing, Central South University, China

BIO-BYWORD SCIENTIFIC PUBLISHING PTY LTD

(619 649 400)

Level 10

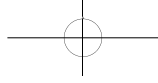
50 Clarence Street

SYDNEY NSW 2000

Copyright © 2024. Bio-Byword Scientific Publishing Pty Ltd.

Complimentary Copy





ISSN (ONLINE): 2208-3693

ISSN (PRINT): 2208-3685



Journal of Clinical and Nursing Research

Focus and Scope

Journal of Clinical and Nursing Research (JCNR) is an international, peer reviewed and open access journal that seeks to promote the development and exchange of knowledge which is directly relevant to all clinical and nursing research and practice. Articles which explore the meaning, prevention, treatment, outcome and impact of a high standard clinical and nursing practice and discipline are encouraged to be submitted as original article, review, case report, short communication and letters.

Topics covered by not limited to:

- Development of clinical and nursing research, evaluation, evidence-based practice and scientific enquiry
- Patients and family experiences of health care
- Clinical and nursing research to enhance patient safety and reduce harm to patients
- Ethics
- Clinical and Nursing history
- Medicine

About Publisher

Bio-Byword Scientific Publishing is a fast-growing, peer-reviewed and open access journal publisher, which is located in Sydney, Australia. As a dependable and credible corporation, it promotes and serves a broad range of subject areas for the benefit of humanity. By informing and educating a global community of scholars, practitioners, researchers and students, it endeavors to be the world's leading independent academic and professional publisher. To realize it, it keeps creative and innovative to meet the range of the authors' needs and publish the best of their work.

By cooperating with University of Sydney, University of New South Wales and other world-famous universities, Bio-Byword Scientific Publishing has established a huge publishing system based on hundreds of academic programs, and with a variety of journals in the subjects of medicine, construction, education and electronics.

PublisherHeadquarter

BIO-BYWORD SCIENTIFIC PUBLISHING PTY LTD

Level 10

50 Clarence Street

Sydney NSW 2000

Website: www.bbwpublisher.com

Email: info@bbwpublisher.com

Table of Contents

1	Clinical Application of Skin Wound Adhesive (Glue) in Skin Incisions <i>Huafeng Kang</i>
5	Clinical Observation of Cefixime Combined with Montmorillonite Powder in Treating Pediatric Bacterial Enteritis <i>Manman Sun</i>
11	The Effect of Upper Limbs on Dosage in Gamma Knife Treatment <i>Gang Yin, Weijie Lei</i>
21	Innovative Nanoparticle Synthesis and Multifaceted Applications in Medicine and Cancer Therapy <i>Zartasha Aftab, Syed Muhammad Ahmad Bukhari, Muhammad Abubakar, Hafiz Muhammad Sultan, Muhammad Zubair, Maysoon Ahmed Abou El Niaaj</i>
36	Analysis of Factors Affecting Non-Invasive Ventilation Failure in AECOPD Patients with Type II Respiratory Failure <i>Huijun Li, Hui Sheng, Zhaoshuang Lu, Ruixiang Zhou, Weizhong Wu, Jinling Gao, Hongying Chu, Dongyang Chen</i>
41	A Case Report of Disseminated Nocardiosis <i>Rong Pang, Lingwei Wang</i>
49	The Impact of Bundled Nursing Interventions Based on Empowerment Theory on Patients with Indwelling Urinary Catheters <i>Yongna Qu</i>
55	Observation on the Effectiveness of Yinzhihuang Granules in the Treatment of Neonatal Jaundice <i>Xingwen Zhou, Boxia Li, Lin Zhu, Jianping Zhang, Wenyan Cheng, Yuhui Wei</i>
61	The Role of Telemedicine in Transforming Palliative Nursing Care: Challenges and Implications for End-of-Life Care <i>Qianya Zhang</i>
67	Medication Selection and Nursing Interventions for Parkinson's Disease Patients <i>Qian Lv, Yingying Li, Xiujuan Wei</i>

- 73 **Analysis of the Causes of Insomnia in Young and Middle-aged People and Nursing Intervention Strategies of Traditional Chinese and Western Medicine**
Weifeng Chen, Yanyan Qin, Cheng Cheng, Xiaojia Zhou
- 82 **Application of a Chest Compression Device Combined with Extended Self-Care for Scar Prevention in Patients After Keloid Excision Surgery**
Min Shen, Miao Chen
- 88 **Satisfaction in Birth Experience among Women with Doula Delivery Support: A Correlational-Comparative Study**
Jingwen Wang, Ma. Theresa Salinda
- 96 **A Review of the Pharmacological Effects and Clinical Potential of *Angelica sinensis***
Jing Ma, Shiyu Zhang, Wenya He, Pengliang Yun
- 102 **The Practical Pathways of Enhancing Nursing Education in Medical Schools**
Jie Mei, Yichun Gao, Genxiao Ding, Yinbiao Wang
- 108 **Research on Teaching Reform of Pathology Courses in Colleges and Universities under the Background of “Internet plus New Medical Science”**
Ziwei Hong
- 114 **Umbilical Cord Mesenchymal Stem Cell-Derived Exosomes Inhibit the Proliferation and Invasion of Uterine Fibroblast Cells**
Hai Tang, Xin Luo, Xiuyin Shen, Yingchun Wan, Zhengping Liu
- 123 **Research on Advances in Early Rehabilitation Intervention for Dysphagia**
Sutao Si
- 130 **Effectiveness Evaluation of Need-Based Nursing for Hemodialysis Patients with Uremia**
Jing Li
- 136 **Clinical Characteristics and Prognostic Analysis of Hepatitis Complicated with Acute Pancreatitis**
Jie Gao, Qiufeng He, Zhili Chen, Yang Deng, Li Wei, Qingfen Ye, Yu Xiao, Jing Peng, Ting Su, Chuangjie Mao

- 147 **Analysis of Tacrolimus Combined with Glucocorticoids for Refractory Nephrotic Syndrome**
Guoxing An, Xueyan Han
- 154 **Application Value of Targeted Nursing Intervention for Pediatric Nutritional Iron-Deficiency Anemia**
Li Sun
- 160 **Exploring the Interplay Between Cancer, Health, and Inflammation**
Sikandar Naseer, Gulnaz Tasleem, Bareera Zahoor, Bisma Hadi, Amna Amin, Alishba Hadi
- 174 **Research Progress and Mechanisms of Acupuncture Combined with Transcutaneous Vagal Nerve Stimulation in the Treatment of Cognitive Impairment after Stroke**
Shan Yang, Yongjie Gong, Kai Wu, Haoxing Lei, Yalan Yu
- 185 **Therapeutic Efficacy of Reduced Glutathione in Emergency Treatment of Organophosphorus Pesticide Poisoning and Its Impact on ALT, AST, CRP, and IL-6 Levels**
Yuezhou Wang
- 191 **Clinical Observation of Carteolol Hydrochloride Eye Drops Combined with Travoprost Eye Drops in the Treatment of Open-Angle Glaucoma**
Fangning Wang
- 198 **Application of Multidisciplinary Collaborative Interventions in the Early Rehabilitation of Patients with Hemorrhagic Stroke and Kinesiophobia**
Lihua Zhang, Yuping Jiang, Wei Zhang
- 205 **Analysis of the Current Filing Status of Traditional Chinese Medicine Preparations Using Traditional Technology in Medical Institutions of Shaanxi Province**
Ruizhong Wang, Yurong Zhang, Shaoli Liang, Yan Wu, Ping Li, Dong Wei, Yanxia Zheng
- 216 **Effect of a Chest Compression Device for Scar Prevention Combined with Nurse-Patient WeChat Group on Scar Formation after Keloid Excision**
Miao Chen, Min Shen
- 223 **Analysis of the Impact of Nutritional Intervention Combined with Predictive Nursing on the Nutritional Status, Quality of Life, and Adverse Reactions in Patients Undergoing Chemotherapy for Lung Cancer**
Meng Sun

- 230 Study on the Anti-Radiation Function of Selenium-Enriched *Agaricus blazei* Murill Polysaccharides and Tea Polyphenol Compound Solution**
Xu Zhou, Xinming Chi, Lan Wang, Haiyang Ju
- 235 Construction and Application Study of Postoperative Nursing Intervention Program for Osteoporotic Vertebral Compression Fractures**
Yanan Niu, Han Chen, Yan Wang, Hongxia Song, Jin Lu, Qi Tang, Wenshan Gao, Ying Li
- 242 Evidence-based Nursing and Improving Patient Satisfaction: A Systematic Evaluation**
Jing Chen
- 247 Development and Validation of a Frailty Risk Prediction Model for Community-Dwelling Elderly in Shanghai**
Jiaming Yuan, Shunshun Zhang, Xueying Ji, Yiqin Huang
- 266 Clinical Implications of Eosinopenia in Adult Brucellosis Patients**
Luxuan Yang, Dan Xiao, Chuanwu Zhu, Haiyan Wang, Wenyong Zhang, Jianguo Chang, Meiqin Liu, Xiujuan Shen

Clinical Application of Skin Wound Adhesive (Glue) in Skin Incisions

Huafeng Kang*

Second Affiliated Hospital of Xi'an Jiaotong University, Xi'an 710004, Shaanxi Province, China

*Corresponding author: Huafeng Kang, marshelllin@126.com

Copyright: © 2024 Author(s). This is an open-access article distributed under the terms of the Creative Commons Attribution License (CC BY 4.0), permitting distribution and reproduction in any medium, provided the original work is cited.

Abstract: *Objective:* To explore the clinical application of skin wound adhesive (glue) in skin incisions. *Methods:* Data from 46 patients who underwent surgery in our hospital between June 2024 and August 2024 were collected, focusing on breast surgery incisions as the study subject, with follow-up observations conducted for 1–2 weeks. *Results:* All incisions healed well without splitting, allergic reactions, or infections, and no adverse reactions were observed. *Conclusion:* The application of skin wound adhesive (glue) in breast surgery incisions is effective and safe; the adhesive process is convenient for external body incisions, eliminates the need for suture removal, shortens patient surgery and hospital stays, and reduces incision infection risk, resulting in satisfactory incision healing outcomes.

Keywords: Skin wound adhesive (glue); Skin incision, N-butyl cyanoacrylate; 2-octyl cyanoacrylate

Online publication: November 28, 2024

1. Introduction

Medical skin wound adhesive is a medical glue used for bonding minor skin wounds and is widely used for closing, hemostasis, and securing skin incisions^[1-3]. Its main component, α -cyanoacrylate, is known for its excellent physical and chemical properties and good biocompatibility^[4-6]. In recent years, with advancements in medical technology, medical skin wound adhesives have shown great advantages and potential in clinical applications^[7-9]. This study selected 46 surgical patients to evaluate the clinical application of “Yishumei” skin wound adhesive (glue) for incision treatment.

2. Materials and methods

2.1. General information

A total of 46 patients who underwent breast surgery in our hospital from June to August 2024 were selected as study subjects. Among them, there were 2 males and 44 females, resulting in a male-to-female ratio of 1:22.

The age range of the patients was 16 to 64 years (41.59 ± 5.67), with incision lengths ranging from 23 to 54 mm (38.49 ± 2.46) and depths reaching the fat layer. All incisions were linear.

2.2. Methodology

The skin wound adhesive used was “Yishumei” skin wound adhesive (produced by Chongqing Gexin Medical Technology Co., Ltd., registration number: Yu Medical Device Certificate 20212020156), with n-butyl cyanoacrylate and 2-octyl cyanoacrylate as the main components.

After surgery, the wound was disinfected with povidone-iodine, and the incision was carefully cleaned. The subcutaneous dermal layer was sutured with absorbable sutures, and the skin surface of the incision was aligned and coated with the skin wound adhesive. Once the adhesive had solidified, the incision was uncovered. After drying, the wound could be covered with a dressing. Patients were observed and followed up for 1–2 weeks postoperatively.

2.3. Observation indicators

- (1) Time taken for the adhesive application, adhesive film formation time, film appearance, and incision closure post-film formation.
- (2) Pain sensation during adhesive application.
- (3) Film detachment condition.
- (4) Observation of any wound reopening post-closure.
- (5) Presence of infection or allergic reaction at the wound site.
- (6) Observation of any other adverse reactions in patients.

3. Results

The entire process took about 2 minutes, with the adhesive forming a film within approximately 1 minute. The adhesive film was well-adhered to the wound surface, ensuring a tight incision closure. Patients did not report any pain during the application process. The adhesive film naturally detached along with the stratum corneum between days 5 and 7. Follow-up observation indicated that all wounds healed well, with no incidences of reopening, infection, or allergic reactions at the wound site. Additionally, no other adverse reactions were observed during the follow-up period.

4. Discussion

Suturing skin incisions is an indispensable part of surgical procedures. Using suitable suturing techniques and materials can reduce the risk of complications, promote wound healing, and improve patients' quality of life. Traditional medical sutures have strong mechanical strength and controllability, making them suitable for most routine surgical incisions. However, the suturing process is relatively complex and requires specific skills and experience. Additionally, the removal of sutures adds extra steps, increasing the risk of infection and scar formation.

With advancements in medical adhesive technology, cyanoacrylate-based adhesives have been developed, containing strong electron-withdrawing groups (e.g., cyano groups) in their monomer composition. Upon

contact with weak nucleophilic substances (e.g., water), these groups trigger a rapid anionic polymerization reaction, instantly transforming the liquid adhesive into a solid, thus achieving adhesion. This polymerization reaction completes within 6–15 seconds. Once solidified, the adhesive forms a waterproof bond that securely closes the wound, reduces inflammation and tissue necrosis, and promotes local tissue growth and repair. Clinicians have begun using these adhesives for small superficial skin incisions or in emergency situations.

In this study, surgical incisions measuring 3–5 cm in length and reaching the fat layer depth were treated with a skin wound adhesive containing n-butyl cyanoacrylate and 2-octyl cyanoacrylate. The application of this adhesive in breast surgery simplified the suturing process, reducing both the surgical time and technical difficulty. The close adhesion of the skin facilitated faster healing, and the adhesive film naturally detached along with the stratum corneum, eliminating the need for additional procedures. Throughout the follow-up, no allergic reactions, infections, or adverse effects were observed, confirming the safety and effectiveness of this product.

5. Conclusion

In summary, this type of skin wound adhesive is suitable for incisions reaching the fat layer depth. It simplifies the process of adhering superficial incisions, eliminates the need for suture removal, reduces operative and hospitalization time, and minimizes infection risk, with good wound healing outcomes. The adhesive demonstrates high clinical applicability.

Disclosure statement

The author declares no conflict of interest.

References

- [1] Chen YQ, Wang XP, Zhang XM, 2023, Progress in Medical Adhesives Based on Bionic Natural Products for Skin Wound Healing. *China Medical Cosmetology*, 13(1): 49–52.
- [2] Liang B, 2022, Research on the Application of Medical Adhesives in Skin Incisions. *Heilongjiang Traditional Chinese Medicine*, 2022(1): 51.
- [3] Zhu XH, Yang HM, 2023, Study on the Closure Performance of Medical Adhesives for Superficial Incisions. *Chinese Veterinary Medicine Journal*, 2023(11): 25–27.
- [4] Liu WZ, Zhang ZX, 2007, Current Status and Prospects of α -Cyanoacrylate Instant Adhesives. *China Adhesives*, 16(2): 4.
- [5] Tian X, Lu YS, 2007, Special Adhesives – α -Cyanoacrylate-Based Medical Adhesives. *New Chemical Materials*, 2007(S1): 4.
- [6] Li YT, 2024, Method for Preparing Medical Glue Using α -Cyanoacrylate Alkyl Ester Monomers: CN202010700647.0. CN111714685A. Published November 4, 2024.
- [7] Liu ZH, Lin YY, Chen S, et al., 2024, Applications of Biomimetic Natural Polymer Hydrogels in Medical Materials. *Polymer Bulletin*, 37(2): 162–173.
- [8] Gao Y, 2023, Construction of Natural Polymer Powder Adhesives and Research on the Development of Medical Dressings, dissertation, Beijing University of Chemical Technology.

- [9] Zhu HF, Mao HL, Gu ZW, 2020, Research Progress of Medical Tissue Adhesives. China Progress in Materials Science, 39(7): 16.

Publisher's note

Bio-Byword Scientific Publishing remains neutral with regard to jurisdictional claims in published maps and institutional affiliations.

Clinical Observation of Cefixime Combined with Montmorillonite Powder in Treating Pediatric Bacterial Enteritis

Manman Sun*

Fourth Affiliated Hospital of Nanjing Medical University, Nanjing 210000, Jiangsu Province, China

*Corresponding author: Manman Sun, 15850634864@163.com

Copyright: © 2024 Author(s). This is an open-access article distributed under the terms of the Creative Commons Attribution License (CC BY 4.0), permitting distribution and reproduction in any medium, provided the original work is cited.

Abstract: *Objective:* To evaluate the clinical efficacy of cefixime (Cef) combined with montmorillonite powder (MP) in treating pediatric bacterial enteritis. *Methods:* Seventy-two cases of bacterial enteritis in children admitted between October 2021 and October 2023 were selected and randomly divided into two groups. The combination group received Cef treatment alongside MP, while the control group received only Cef treatment. The groups were compared based on overall efficacy, symptom relief time, and other indicators. *Results:* The combination group showed a higher overall efficacy, shorter symptom relief time, lower levels of inflammatory markers post-treatment, and a higher proportion of normal and grade I dysbiosis in the intestinal flora, with significant differences compared to the control group ($P < 0.05$). *Conclusion:* Cef combined with MP is significantly effective in treating pediatric bacterial enteritis, promoting symptom relief, reducing inflammation, and correcting intestinal flora imbalance.

Keywords: Cefixime; Montmorillonite powder; Pediatric bacterial enteritis; Clinical efficacy

Online publication: November 28, 2024

1. Introduction

Bacterial enteritis is a common infectious disease among children. Due to their young age, immature organ function, poor immunity, and often inadequate hygiene practices—such as improper handwashing and unclean eating habits—children are highly susceptible to bacterial enteritis^[1]. Common pathogens include *Escherichia coli* and *Salmonella*, which produce large amounts of endotoxins in the intestine, disrupting intestinal flora balance and causing diarrhea. Currently, antibiotics like cefixime (Cef) are foundational drugs for this condition, providing antibacterial action and reducing intestinal inflammation. However, using Cef alone can impair the physiological barrier function of the intestinal mucosa and may lead to the development of antibiotic-resistant strains, affecting long-term efficacy. Thus, combining Cef with montmorillonite powder (MP) may

help bind and adsorb pathogenic bacteria, ensuring their excretion via feces, thereby regulating intestinal flora and improving prognosis in children. Based on this, the present study selected 72 cases of pediatric bacterial enteritis to analyze the clinical efficacy of Cef combined with MP.

2. Materials and methods

2.1. General information

Seventy-two pediatric patients diagnosed with bacterial enteritis and treated between October 2021 and October 2023 were included. Patients were randomly divided into two groups. The combination group included 36 cases (19 males, 17 females) aged 1–10 years, with a mean age of 5.48 ± 1.47 years and a disease duration of 2–14 days, averaging 7.53 ± 1.48 days. The control group included 36 cases (21 males, 15 females) aged 2–11 years, with a mean age of 5.69 ± 1.53 years and a disease duration of 3–13 days, averaging 7.91 ± 1.62 days. Comparison of baseline data between the two groups showed no significant differences ($P > 0.05$).

Inclusion criteria: Patients met the diagnostic criteria for bacterial enteritis as outlined in “Practical Internal Medicine”^[2]; exhibited symptoms such as diarrhea and abdominal pain, with diarrhea occurring ≥ 4 times per day; presented mucus in stools, with pathogenic bacteria detected in stool cultures and a white blood cell count $> 12 \times 10^9/L$; and had complete basic information available.

Exclusion criteria: Patients were excluded if they had thyroid dysfunction, were allergic to the study medications, had received hormone or antibiotic treatment within the past week, or withdrew from the study mid-course.

2.2. Methods

The control group received Cef treatment at an oral dose of 1.5–3.0 mg/kg, administered twice daily for 7 days.

In the combination group, patients received both Cef and MP treatment. The MP dose was 1.0–3.0 g per oral dose, administered three times daily for 7 days.

2.3. Observation indicators

- (1) Symptom relief time and hospitalization duration: Time until the fever subsides, stool frequency and consistency normalize, and vomiting resolves.
- (2) Inflammatory markers: Venous blood samples (5 mL, fasting) were centrifuged, and procalcitonin (PCT) levels were measured using an automatic biochemical analyzer via immunoturbidimetric assay; interleukin-8 (IL-8) via enzyme-linked immunosorbent assay; and tumor necrosis factor-alpha (TNF- α) using the same method as IL-8.
- (3) Degree of intestinal flora imbalance: Fresh stool samples (2–3 g) were air-dried, Gram-stained, and observed under an oil-immersion microscope. A count of 1,000 bacteria was used as a baseline. Bacteria counts of 501–5,000 per field were considered normal; 101–500 indicated grade I imbalance; 11–100 indicated grade II imbalance; and < 11 indicated grade III imbalance.

2.4. Efficacy evaluation criteria

- (1) Markedly effective: Symptoms resolved, and stool normalized after 3 days of continuous treatment.
- (2) Effective: Symptoms improved, and stool was mostly normal after 3 days of continuous treatment.

(3) Ineffective: No improvement in symptoms or stool condition after 3 days of continuous treatment.

2.5. Statistical analysis

Data were processed using SPSS 28.0. Measurement data were expressed as mean \pm standard deviation (SD), with comparisons tested using the *t*-test; count data were expressed as [*n* (%)], with comparisons tested using the χ^2 test. Results were considered statistically significant at $P < 0.05$.

3. Results

3.1. Comparison of overall effective rate between groups

Table 1 shows that the combination group exhibited a higher overall effective rate than the control group ($P < 0.05$).

Table 1. Comparison of overall effective rate between groups [*n* (%)]

Group	Cases	Markedly effective	Effective	Ineffective	Overall effective rate
Combination	36	19 (52.78)	16 (44.44)	1 (2.78)	35 (97.22)
Control	36	14 (38.89)	15 (41.67)	7 (19.44)	29 (80.56)
χ^2					5.063
<i>P</i>					0.024

3.2. Comparison of symptom relief time and hospitalization duration between groups

Table 2 shows that the combination group demonstrated shorter symptom relief and hospitalization times compared to the control group ($P < 0.05$).

Table 2. Comparison of symptom relief time and hospitalization duration between groups (mean \pm SD, days)

Group	Cases	Fever relief time	Stool frequency normalization	Stool consistency normalization	Vomiting relief time	Hospitalization time
Combination	36	1.85 \pm 0.39	3.21 \pm 0.48	2.94 \pm 0.41	2.31 \pm 0.44	4.88 \pm 0.94
Control	36	2.27 \pm 0.45	4.09 \pm 0.53	3.69 \pm 0.54	3.09 \pm 0.49	6.09 \pm 0.98
<i>t</i>		4.232	7.384	6.637	7.106	5.346
<i>P</i>		0.000	0.000	0.000	0.000	0.000

3.3. Comparison of inflammatory factor levels between groups

Before treatment, no significant differences were observed in inflammatory factor levels between the groups ($P > 0.05$). After 7 days of treatment, the inflammatory factor levels in the combination group were significantly lower than those in the control group ($P < 0.05$), as shown in **Table 3**.

Table 3. Comparison of inflammatory factor levels between groups before and after treatment (mean \pm SD, pg/mL)

Group	Cases	PCT		IL-8		TNF- α	
		Before	After	Before	After	Before	After
Combination	36	9.24 \pm 1.53	3.35 \pm 0.40	17.85 \pm 1.46	10.17 \pm 1.30	5.76 \pm 0.51	2.09 \pm 0.27
Control	36	9.28 \pm 1.55	6.17 \pm 0.57	17.63 \pm 1.52	14.46 \pm 1.35	5.78 \pm 0.54	3.84 \pm 0.31
<i>t</i>		0.110	24.298	0.626	13.734	0.162	25.541
<i>P</i>		0.913	0.000	0.533	0.000	0.872	0.000

3.4. Comparison of the degree of intestinal flora imbalance between groups

Table 4 shows that the combination group showed a higher proportion of normal and grade I imbalance in intestinal flora compared to the control group ($P < 0.05$).

Table 4. Comparison of the degree of intestinal flora imbalance between groups [n (%)]

Group	Cases	Normal	Grade I imbalance	Grade II imbalance	Grade III imbalance
Combination	36	21 (58.33)	10 (27.78)	4 (11.11)	1 (2.78)
Control	36	12 (33.33)	3 (8.33)	16 (44.44)	5 (13.89)
χ^2		4.532	4.560	9.969	2.909
<i>P</i>		0.033	0.032	0.002	0.088

4. Discussion

The primary cause of bacterial enteritis is bacterial infection, with contributing factors including environmental contamination, underdeveloped digestive systems in children, and poor hygiene awareness. It frequently presents with abdominal pain, mucus-laden stool, and other gastrointestinal symptoms, peaking in incidence during summer and autumn. Bacterial enteritis can often lead to complications such as electrolyte imbalances and toxin responses^[3]. Currently, treatment predominantly involves medication, with Cef orally administered as a primary therapy. As a third-generation cephalosporin, Cef targets a range of bacterial β -lactamases with high selectivity and potent antibacterial properties, clearing inflammatory factors in pediatric patients. Its mechanism involves a specific action on gram-negative bacteria, altering endotoxin structures, blocking the release of inflammatory factors, and accelerating recovery. However, Cef's prolonged oral administration can lead to strong resistance, making bacterial enteritis challenging to cure, hence the need for combination therapy with other drugs like MP. MP, rich in stratified structures, can immobilize bacteria and toxins in the intestines, effectively inhibiting their proliferation. This medication adheres to the intestinal mucosa surface and binds efficiently to mucin glycoproteins, thereby improving the physiological function of mucosal protective agents^[4]. Combined, these two drugs restore intestinal microecology balance and protect mucosal function, resulting in superior therapeutic outcomes.

In this study, the overall effective rate in the combination group was higher than that in the control group ($P < 0.05$), aligning closely with the findings of Xie^[5]. Symptom relief time and hospitalization duration

were shorter in the combination group, with lower levels of post-treatment inflammatory factors and a higher proportion of normal and grade I imbalance in intestinal flora compared to the control group, all with significant differences ($P < 0.05$). The effectiveness of Cef is attributed to its strong activity against gram-negative bacteria, which disrupts bacterial structures, regulates β -lactamase secretion, inhibits effective cell wall synthesis, and reduces inflammatory factor levels^[6,7]. When combined with MP, treatment efficacy is significantly enhanced. MP, being soluble and multilayered, contains core components of dioctahedral montmorillonite particles, which prevent persistent bacterial irritation to the intestines, reduce bacterial toxicity, relieve diarrhea, and assist in anti-inflammatory actions, alleviating inflammation in patients. Additionally, MP improves absorption in intestinal cells, reduces digestive fluid secretion, and enhances mucus cohesion, restoring the mucosal barrier, promoting peristalsis, and correcting flora imbalances^[8]. This combined treatment leverages synergistic mechanisms that improve local metabolic capacity and enhance the immune function of pediatric patients, expediting recovery and shortening the treatment course. Furthermore, combined therapy reduces Cef treatment duration, minimizes drug accumulation in children, prevents antibiotic misuse, and mitigates adverse effects such as nausea and vomiting, ensuring high medication safety.

5. Conclusion

In summary, the combined use of Cef and MP offers optimal therapeutic efficacy for pediatric bacterial enteritis, alleviating symptoms, shortening hospital stays, reducing inflammation, and improving pathological manifestations like intestinal flora imbalance, highlighting its high clinical value.

Disclosure statement

The author declares no conflict of interest.

References

- [1] Wang H, Jiang M, Wu C, 2021, Effect of Ambroxol Hydrochloride Combined with Cefixime on Serum Inflammatory Cytokines and Clinical Efficacy in Pediatric Asthmatic Bronchitis. *Maternal and Child Health Care of China*, 36(10): 2305–2308.
- [2] Lin G, Wang J, Ge J, 2017, Practical Internal Medicine, 1st–15th editions. Science and Publishing, 2017, No.276(12): 2.
- [3] Jiang Y, Chen C, Gao H, et al., 2022, Effect of Bifidobacterium and Lactobacillus Triple Live Bacterial Tablets Combined with Montmorillonite Powder on Inflammatory Levels and Intestinal Flora in Children with Viral Infectious Enteritis. *International Journal of Laboratory Medicine*, 43(5): 580–584 + 590.
- [4] Zhu Y, Wang Y, 2022, Clinical Efficacy of Xingpi Yang'er Granules Combined with Montmorillonite Powder in the Treatment of Pediatric Rotavirus Enteritis and Its Effect on Inflammatory Factors and Myocardial Enzyme Profile. *China Medical Herald*, 24(7): 687–691.
- [5] Xie Y, 2024, Clinical Observation on the Efficacy of Cefixime Combined with Montmorillonite Powder in the Treatment of Pediatric Bacterial Enteritis. *Capital Food and Medicine*, 31(5): 47–49.
- [6] Chen S, 2021, Comparison of the Effects of Cefixime and Cefaclor in the Treatment of Pediatric Bacterial Enteritis. *Clinical Medicine*, 41(2): 106–107.

- [7] Zhang L, Wang R, Li J, 2023, Study on the Effect of Pudilan Oral Liquid Combined with Cefixime in the Treatment of Pediatric Upper Respiratory Tract Infection. *Life Science Instruments*, 21(6): 79–81.
- [8] Wang J, Jia Y, Li H, et al., 2023, Clinical Study of Xia’ershugan Granules Combined with Cefixime in the Treatment of Pediatric Acute Bacterial Upper Respiratory Tract Infection. *Modern Drugs and Clinics*, 38(1): 131–136.

Publisher’s note

Bio-Byword Scientific Publishing remains neutral with regard to jurisdictional claims in published maps and institutional affiliations.

The Effect of Upper Limbs on Dosage in Gamma Knife Treatment

Gang Yin¹, Weijie Lei^{2*}

¹Gamma Knife Center, Second Affiliated Hospital of Xuzhou Medical University, Xuzhou 221000, Jiangsu Province, China

²Radiotherapy Center, Second Affiliated Hospital of Xuzhou Medical University, Xuzhou 221000, Jiangsu Province, China

**Corresponding author:* Weijie Lei, weijie_lei@163.com

Copyright: © 2024 Author(s). This is an open-access article distributed under the terms of the Creative Commons Attribution License (CC BY 4.0), permitting distribution and reproduction in any medium, provided the original work is cited.

Abstract: *Objective:* To study the effect of the upper limbs on dosage in Gamma Knife treatment. *Methods:* The design function of the Luna-260TM Gamma Knife Radiotherapy Planning System was utilized, using a body phantom to simulate conventional treatment sites. Twenty sampling points were set for irradiation locations. Using five different collimator sizes commonly used in body treatments, treatment plans were designed under conditions with and without upper limbs, and sampling point irradiation time comparison data was collected to calculate and analyze dose error rates. *Results:* Across the 20 sampling points, the dose error range was from -16.09% to 0 when comparing treatment plans without upper limbs to those executed with upper limbs present, and from 0 to 19.75% in the reverse comparison. With the same prescription dose, location, and collimator size, dose error increased as the irradiation site moved closer to the upper limbs and decreased as the distance increased. *Conclusion:* In Gamma Knife treatment, the dose error decreases as the irradiation site is further from the upper limbs and increases when closer. Consistency in upper limb positioning is essential during Gamma Knife localization, planning, and execution. Although small, the upper limbs can significantly impact dosage, requiring stringent quality control to ensure the precision of treatment doses, thus safeguarding the effectiveness and safety of patient treatments.

Keywords: Gamma Knife; Upper limbs; Radiotherapy planning; Dosage

Online publication: November 28, 2024

1. Introduction

In radiotherapy planning, delineation is a critical step and includes contouring of the target area, sensitive tissues, organs, and the body surface. The upper limbs, as a minor part of the body, are often overlooked by radiotherapy personnel and are commonly contoured as part of the body surface in treatment plans. Few studies in the literature, both domestic and international, focus on the effect of the upper limbs on dosage, with most

research involving linear accelerators and CyberKnife technology^[1,2]. Currently, no studies on this aspect using the Gamma Knife have been identified.

This study aims to simulate scenarios with and without the upper limbs to collect and compare corresponding data, analyzing the impact of upper limbs on dose in different irradiation locations. Using clinical case data, the study further examines the extent of dose deviation due to the upper limbs under varying conditions. This aims to raise awareness among radiotherapy personnel regarding the importance of upper limb positioning for dose accuracy, thereby enhancing treatment efficacy and patient safety.

2. Materials and methods

2.1. Research tools

A homogeneous body phantom with a density close to human tissue was used to simulate positioning and capture CT localization image data. The Xi'an ET Medical Luna-260TM Gamma Knife Radiotherapy Planning System 3.0 (hereafter referred to as "RTPS 3.0") was used to conduct clinical research on the impact of the upper limbs on dosage.

2.2. Research methods

Using the body phantom on the Luna-260TM Gamma Knife body positioning bed and a GE large-aperture 4D-CT simulation machine, the body phantom was positioned and scanned, and the localization images were transmitted to RTPS 3.0 over a network.

In the treatment planning system, the intersection of all beam axes serves as the focal point^[3]. The focal points of the Gamma Knife radiation on the body phantom were used as sampling points to design a comparative treatment plan simulation. All sampling points had target points set so that the arc path passed through the simulated upper limbs to obtain comparison data. The simulation of standard treatment sites on the body took 20 positions as sampling points, with scenarios created for both the presence and absence of upper limbs, as shown in **Figure 1**.

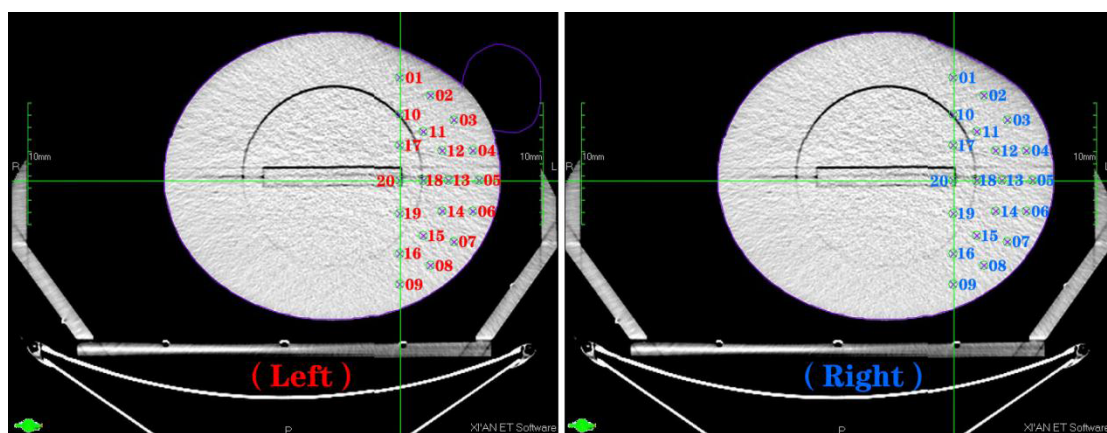


Figure 1. Comparison of sampling points with upper limb (left) and without upper limb (right).

In **Figure 1 (left)**, the purple contour line on the upper right corner represents the simulated upper limb, based on typical limb size; **Figure 1 (right)** shows the absence of the upper limb.

2.3. Method for collecting comparative irradiation time data

The prescription dose was set at 50% of 1000 cGy in a single large dose treatment. Using RTPS, five different collimator sizes (2#, 3#, 4#, 5#, and 6#) commonly used in body treatment were selected, as the 1# collimator was excluded due to its small irradiation field not being applicable in body treatments. The data collection method is shown in **Figure 2**.

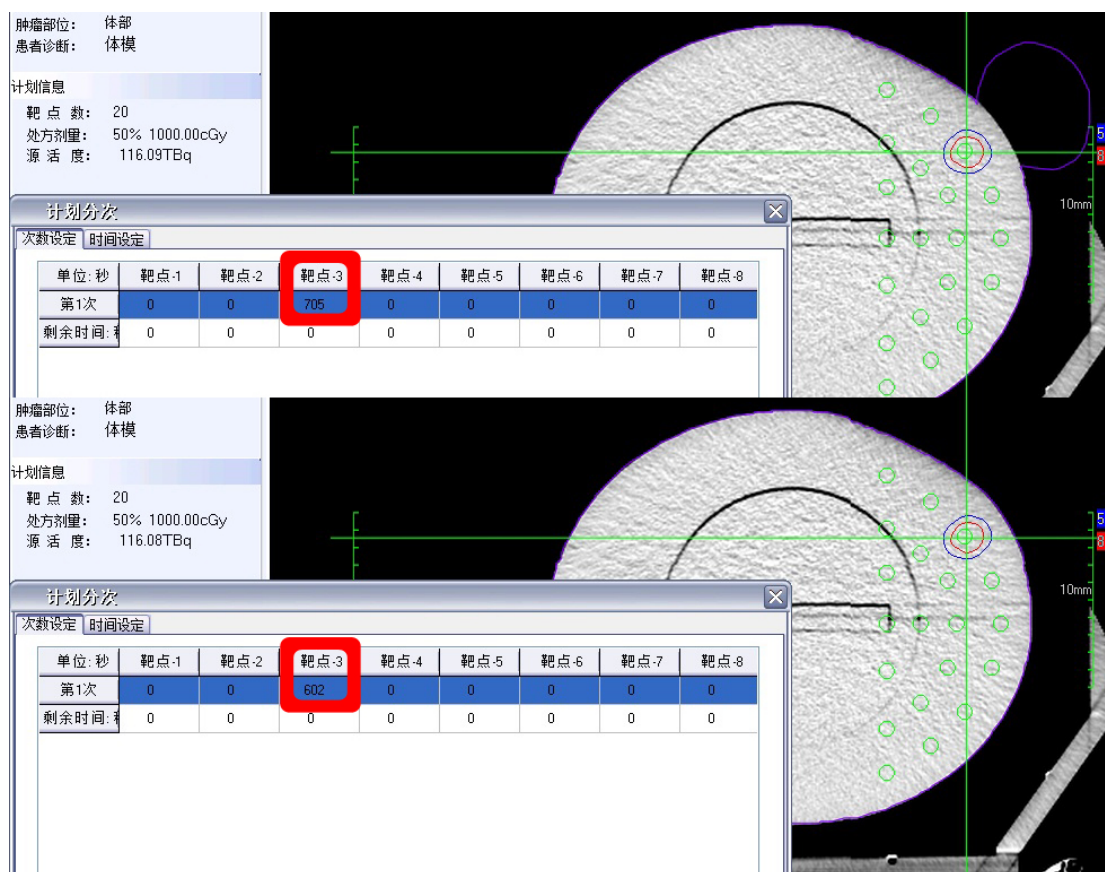


Figure 2. Comparison of irradiation times at sampling points with and without upper limbs for the same prescription dose, collimator, and location

Figure 2 illustrates the irradiation time collected at sampling point 03 using the 4# collimator, with a prescription dose of 50% of 1,000 cGy in a single dose. The upper image shows 705 seconds with the upper limb present, while the lower image shows 602 seconds without the upper limb.

3. Results

3.1. Irradiation time data

Using the data collection method shown in **Figure 2**, a total of 200 treatment plans were designed with 5 collimators, and 200 corresponding irradiation time data points were collected at sampling points with and without the upper limb, as shown in **Table 1**.

Table 1. Comparison of irradiation times for the same dose with different collimators at sampling points with and without the upper limb (irradiation dose: 50% of 1,000 cGy)

Collimator no.	2#	3#	4#	5#	6#	2#	3#	4#	5#	6#
Sampling point ID	Irradiation time with upper limb (s)					Irradiation time without upper limb (s)				
01	760	690	673	642	627	719	653	635	592	586
02	775	706	698	664	646	697	632	621	592	580
03	802	700	705	678	667	687	625	602	593	557
04	725	653	643	594	586	649	596	583	540	530
05	699	618	615	530	505	657	594	581	560	549
06	694	618	611	531	515	675	608	594	521	501
07	707	650	640	580	557	694	639	634	574	546
08	767	678	673	587	563	751	672	666	578	555
09	812	722	726	626	607	812	715	719	625	606
10	879	799	799	761	747	830	754	746	705	694
11	879	779	769	743	728	814	722	720	676	665
12	844	743	741	707	695	780	692	680	646	637
13	808	721	716	679	668	765	694	681	641	638
14	829	723	718	674	669	809	704	699	655	651
15	851	752	749	704	698	836	739	735	699	685
16	886	794	799	747	740	876	785	782	735	729
17	949	856	855	815	798	897	817	810	768	754
18	905	800	791	760	746	879	769	766	719	713
19	964	856	861	815	799	942	837	842	789	781
20	979	889	873	837	817	944	858	848	807	788

3.2. Data processing principle and dose error rate results

The irradiation dose is equal to the focal point dose rate multiplied by the irradiation time ^[4]. Within the same time frame, the focal point dose rate is identical. The irradiation time comparison data collected at the same location on each sampling point differ only by the presence or absence of the upper limb, with all other conditions constant. Therefore, the irradiation dose is proportional to the irradiation time, meaning the comparison of irradiation time data in **Table 1** also reflects the dose error rate for each irradiation position.

For the same prescription dose and collimator size at the same sampling point:

Dose error rate for irradiation without upper limb relative to with upper limb = (Dose without upper limb - Dose with upper limb) / Dose with upper limb = (Irradiation time without upper limb - Irradiation time with upper limb) / Irradiation time with upper limb.

For example, for a prescription dose of 50% of 1,000 cGy using the 4# collimator, the dose error at sampling point 03 without the upper limb compared to with the upper limb = (602 - 705) / 705 = -14.61%. Another example: at sampling point 09, the dose error for the same prescription dose with the 4# collimator is (719 - 726) / 726 = -0.96%. This calculation method yielded 100 comparative dose error rate data points for

irradiation without the upper limb relative to with upper limb, as shown in **Table 2**.

Table 2. The dose error rate for irradiation without the upper limb relative to with upper limb

Collimator no.	2#	3#	4#	5#	6#
Sampling point ID	Dose error rate without upper limb relative to with upper limb				
01	-5.39%	-5.36%	-5.65%	-7.79%	-6.54%
02	-10.06%	-10.48%	-11.03%	-10.84%	-10.22%
03	-14.34%	-10.71%	-14.61%	-12.54%	-16.49%
04	-10.48%	-8.73%	-9.33%	-9.09%	-9.56%
05	-6.01%	-3.88%	-5.53%	5.66%	8.71%
06	-2.74%	-1.62%	-2.78%	-1.88%	-2.72%
07	-1.84%	-1.69%	-0.94%	-1.03%	-1.97%
08	-2.09%	-0.88%	-1.04%	-1.53%	-1.42%
09	0.00%	-0.97%	-0.96%	-0.16%	-0.16%
10	-5.57%	-5.63%	-6.63%	-7.36%	-7.10%
11	-7.39%	-7.32%	-6.37%	-9.02%	-8.65%
12	-7.58%	-6.86%	-8.23%	-8.63%	-8.35%
13	-5.32%	-3.74%	-4.89%	-5.60%	-4.49%
14	-2.41%	-2.63%	-2.65%	-2.82%	-2.69%
15	-1.76%	-1.73%	-1.87%	-0.71%	-1.86%
16	-1.13%	-1.13%	-2.13%	-1.61%	-1.49%
17	-5.48%	-4.56%	-5.26%	-5.77%	-5.51%
18	-2.87%	-3.88%	-3.16%	-5.39%	-4.42%
19	-2.28%	-2.22%	-2.21%	-3.19%	-2.25%
20	-3.58%	-3.49%	-2.86%	-3.58%	-3.55%

3.3. Data analysis

Based on the comparison data in **Table 2**, dose error rate curves were generated for each collimator, comparing irradiation without the upper limb relative to with the upper limb, as shown in **Figure 3**.

Areas with larger dose error rates for each collimator primarily occurred near the upper limb, such as at sampling points 01, 02, 03, 04, 10, 11, and 12, while regions with smaller error rates were further from the upper limb, such as sampling points 07, 08, 09, 15, 16, and 19. Collimators 5# and 6# at sampling point 05 did not match the overall dose error rate curve trend, likely due to their very large irradiation fields, which are not used in clinical practice; therefore, they are excluded from further analysis.

In the range of the 20 sampling points, the dose error rate for irradiation without the upper limb relative to with the upper limb was -16.09% to 0. The inverse calculation of this rate yields a dose error range of 0 to 19.75% for irradiation with the upper limb relative to without.

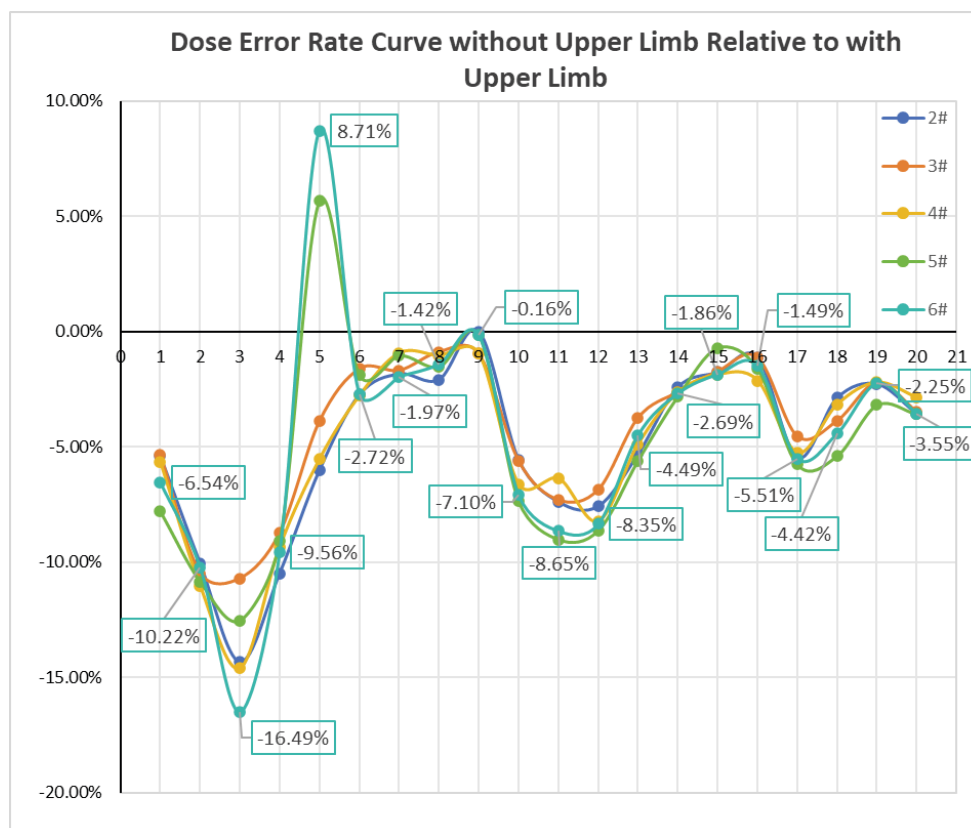


Figure 3. Dose error rate curve without upper limb relative to with upper limb. Note: The horizontal axis represents 20 sampling points on the phantom, and the vertical axis represents the dose error rate percentage. The curves show the dose error rates for collimators 2#, 3#, 4#, 5#, and 6# for irradiation without upper limb relative to with upper limb

4. Clinical plan analysis

A review of representative clinical plans at our Gamma Knife Center was conducted to validate the feasibility of using phantoms to study dose effects with and without the upper limb. This verification also assesses the clinical reference value of dose error rate ranges within sampling points when accounting for the presence or absence of a limb.

4.1. Clinical plan 1

Patient Ou, female, 86 years old, with liver metastasis from breast cancer, received Gamma Knife treatment in February 2023. The total treatment dose was 3,200 cGy at the 50% isodose line, administered over seven sessions. The patient was positioned using a vacuum bag for CT localization. To prevent interference with the CT imaging quality due to her upper limb, she held the limb on the liver side close to her chest, ensuring image clarity. During the treatment planning process, this arm was not visible in the positioning images and therefore could not be contoured, as shown in **Figure 3 (left)**. However, during the actual treatment, if the patient was unable to maintain the exact positioning due to prolonged treatment times, she would naturally place her upper limb on the liver side. In clinical practice, if the upper limb is not immobilized, this phenomenon is likely to occur. The opposing upper limb was used to simulate the scenario with the limb present during actual treatment, as depicted in **Figure 3 (right)**.

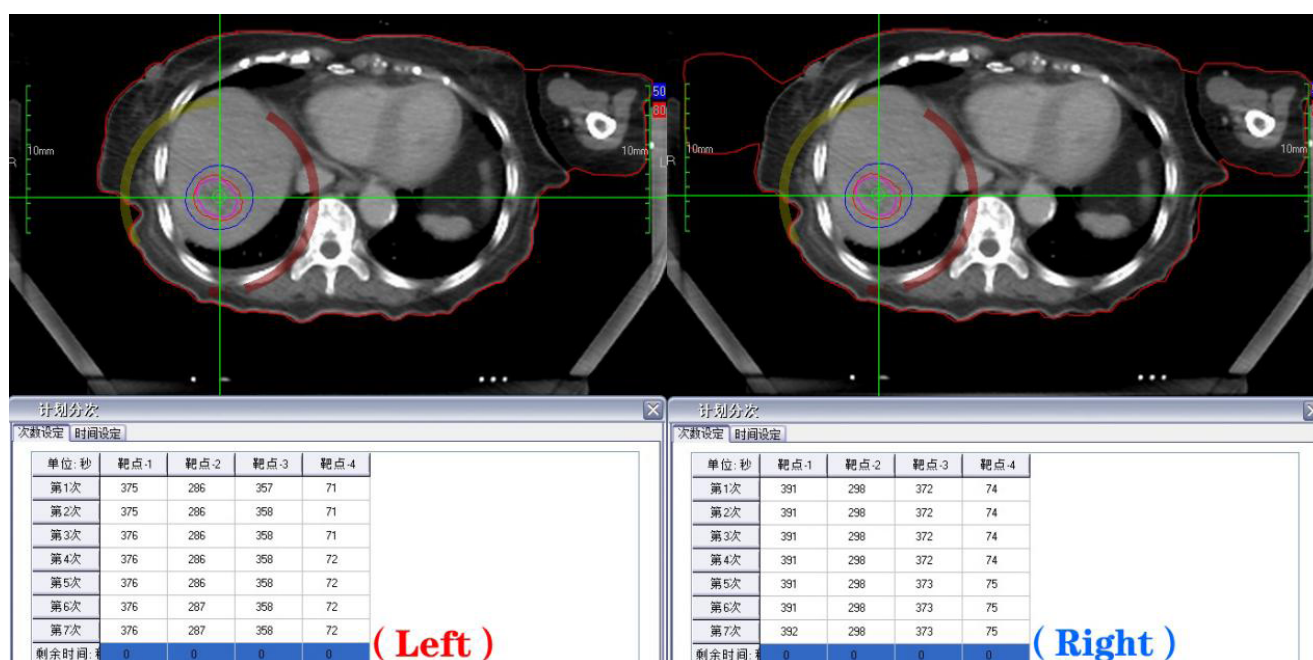


Figure 3. Comparison of planned irradiation times without the upper limb versus actual treatment with the upper limb. Note: In the actual CT localization image during patient positioning, the right upper limb is absent in **Figure 3 (left)**, while the upper limb on the left side is contoured based on the size and position of the contralateral limb to simulate its presence in **Figure 3 (right)**

By comparing the output irradiation times of each plan, the impact of the upper limb on lesion dose was analyzed. In this comparison, target points 1, 3, and 4 used the 4# collimator, while target point 2 used the 5# collimator. The dose error rate without the upper limb relative to the actual treatment with the upper limb was -4.09% for target 1, -4.68% for target 2, -4.03% for target 3, and -4.11% for target 4.

Due to varying distances from each target point to the upper limb, the dose error rates differed, with an average error rate of -4.23%. This indicates that the actual irradiation dose was 4.23% less than the prescription dose, equating to 3,064.64 cGy at the 50% isodose line. In treatment planning, the actual presence of an unmodeled upper limb results in a similar situation, signifying that the actual irradiation dose would fall short of the prescribed dose.

4.2. Clinical plan 2

Patient Li, male, 62 years old, with primary liver cancer, received Gamma Knife treatment in November 2022. The total treatment dose was 3,500 cGy at the 50% isodose line, administered over seven sessions. During positioning with a vacuum bag CT, the patient's arms were normally positioned at his sides. During treatment planning, this arm was contoured as part of the body surface, as shown in **Figure 4 (left)**. However, in actual treatment, if the patient could not maintain the positioning due to prolonged treatment times, he would move his arm away. This occurrence is more common in patients with limited self-control who do not cooperate fully during treatment. For this plan, the other upper limb's size and position were used to simulate the scenario without the arm in the actual treatment, as depicted in **Figure 4 (right)**.

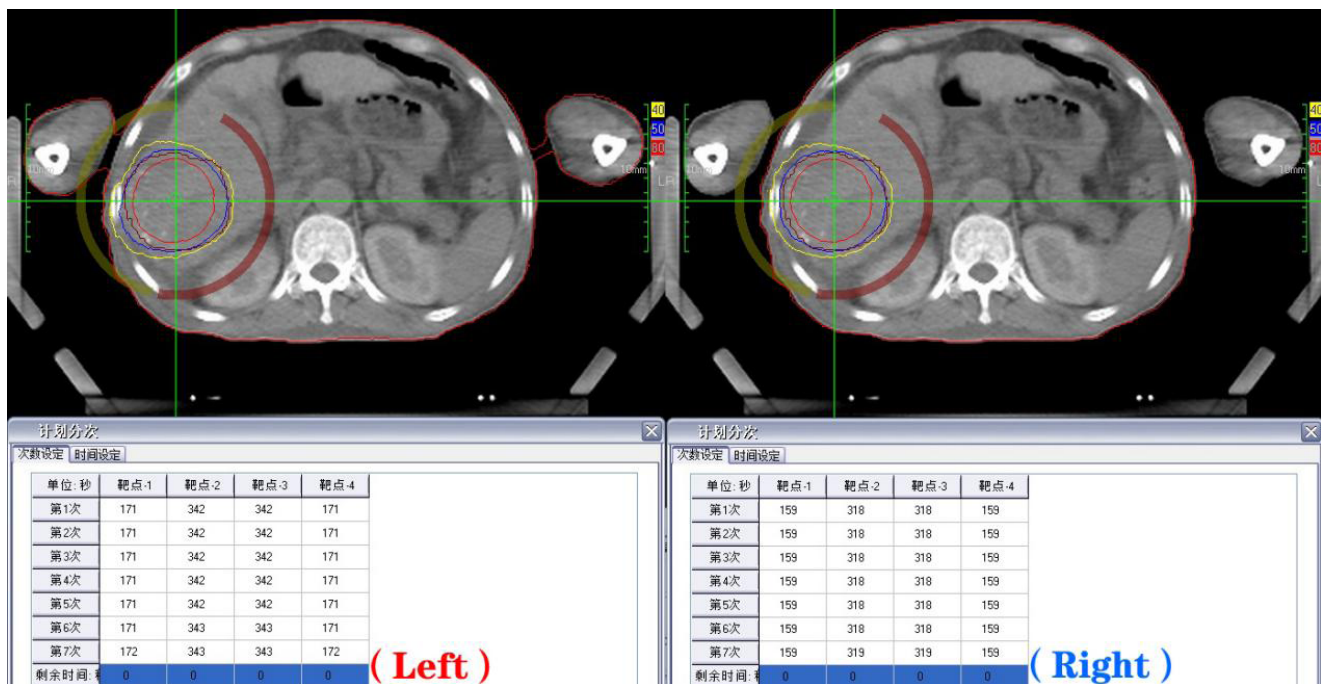


Figure 4. Comparison of planned irradiation times with the upper limb versus actual treatment without the upper limb. Note: The right upper limb is present in **Figure 4 (left)**, while **Figure 4 (right)** simulates the arm being moved out, with no contouring of the arm as part of the body surface

In this comparison, target point 1 used the 5# collimator, while target points 2, 3, and 4 all used the 6# collimator. The dose error rate for irradiation with the upper limb relative to actual treatment without it was 7.55% for target points 1, 2, 3, and 4. If the patient fully moved the arm away during treatment, the actual irradiation dose would increase by 7.55% relative to the prescribed dose, reaching 3,764.25 cGy at the 50% line. As the irradiation site is very close to the skin, this also indicates an increased skin dose. Given that the dose error fluctuates maximally in relation to the closest sampling point with an upper limb, even minor repositioning of the arm can alter the dose. Excessive dose errors may cause the dose for skin or adjacent organs at risk of exceeding critical values, potentially affecting treatment safety under severe circumstances.

5. Discussion

A recent study examined the dosimetric effects of arm positioning on CyberKnife radiotherapy for spinal tumor patients, concluding that even with extreme bilateral arm positions, arm movement had minimal impact on dosimetry during CyberKnife-based spinal tumor radiotherapy^[5,6]. Typically, both domestic and international research methods use parameters from the Dose-Volume Histogram (DVH) within conventional plan evaluation tools to assess dose impact^[7,8]. Although arm positioning can affect dose in specific cases, the influence is generally minor. The limited range of treatment sites in these studies restricts their ability to comprehensively reflect the dose impact of arm positioning on different tumor locations. Additionally, the varying irradiation methods of different devices may affect the degree of influence from the upper limb, warranting further research^[9,10].

This study utilized the Luna-260TM RTPS planning design function and employed phantoms to simulate a broader range of conventional irradiation sites, providing a more comprehensive assessment of the upper limb's

impact on dose in Gamma Knife treatments. By combining the sample point positions from **Figure 1** with the dose error rate curve in **Figure 3**, it is evident that when the Gamma Knife target irradiation path intersects with the upper limb, the further the sample point is from the limb, the smaller the dose error rate; conversely, the closer the sample point, the greater the dose error rate.

Using two distinct types of clinical case plans, this study simulated situations where inconsistent arm positioning between radiotherapy planning and execution could occur if treatment phases were not meticulously controlled. This allowed calculation of the dose error rate between the prescription and the actual delivered dose, determining the patient's actual irradiation dose. The study thus validates the accuracy and practicality of this research method.

6. Conclusion

In summary, when the Gamma Knife target irradiation path intersects with the upper limb, the farther the irradiation point from the limb, the smaller the dose error, while proximity increases the error. It is crucial to maintain consistent arm positioning across Gamma Knife positioning, treatment planning, and execution. Not only must patients cooperate, but staff must also be carefully coordinated to ensure that radiation oncologists, treatment planners (physicists), and technicians diligently oversee every phase of radiotherapy. As Gamma Knife is a form of precision radiotherapy, even small arm-related dose impacts cannot be overlooked. Strict quality control is essential to ensure dose accuracy, which is vital for both the effectiveness and safety of patient treatment.

Disclosure statement

The authors declare no conflict of interest.

References

- [1] Iyengar P, Timmerman RD, 2012, Stereotactic Ablative Radiotherapy for Non-Small Cell Lung Cancer: Rationale and Outcomes. *Journal of the National Comprehensive Cancer Network*, 10(12): 1514–1520.
- [2] Wang J, Liu B, Liu W, 2020, Impact of Arm Position on Volumetric Modulated Arc Therapy for Thoracic Stereotactic Radiotherapy. *Chinese and Western Medicine Combined Cardiovascular Diseases Electronic Journal*, 8(20): 168 + 173.
- [3] Hu C, Huang W, Zhai H, et al., 2020, Analysis of Follow-up Evaluation Results of the Quality Control Detection Specification for X- and Gamma-ray Stereotactic Radiotherapy Systems (WS582-2017). *Chinese Radiation Health*, 29(2): 138–141.
- [4] Huang Z, Cao F, Wang J, et al., 2023, Analysis and Study of Quality Control Measures for Radiotherapy Equipment in Jiangxi Province. *Chinese Medical Device Information*, 29(5): 18–20 + 34.
- [5] Li J, Liu X, Wang G, et al., 2022, Dosimetric Impact of Arm Position on CyberKnife Radiotherapy in Patients with Spinal Tumors. *Journal of Peking University (Health Sciences)*, 54(1): 182–186.
- [6] Jin Y, He S, 2020, Brief Discussion on YY0775-2010 Long-distance Radiotherapy Planning System Requirements for High-energy X (γ) Beam Dose Calculation Accuracy and Test Methods. *Chinese Medical Device Information*, 26(9): 16–17 + 22.

- [7] Li C, Lu J, Tao C, et al., 2017, Analysis of Intensity-Modulated Radiotherapy Plan Dose-Volume Histograms Based on Quartile Values. *Chinese Journal of Radiological Medicine and Protection*, 37(10): 742–746.
- [8] Xu Y, Li X, Sun K, 2012, Comparative Verification Study of Two Radiotherapy Planning Systems. *Tuberculosis and Thoracic Tumor*, 2012(2): 118–120.
- [9] Huang Z, Cao F, Wang J, et al., 2023, Analysis and Study of Quality Control Measures for Radiotherapy Equipment in Jiangxi Province. *Chinese Medical Device Information*, 29(5): 18–20 + 34.
- [10] Cheng Y, Liu D, Xu D, et al., 2018, Clinical Study on Focal Dose Rate in Gamma Knife Treatment of Primary Trigeminal Neuralgia. *Chinese Journal of Minimally Invasive Neurosurgery*, 23(11): 485–487.

Publisher's note

Bio-Byword Scientific Publishing remains neutral with regard to jurisdictional claims in published maps and institutional affiliations.

Innovative Nanoparticle Synthesis and Multifaceted Applications in Medicine and Cancer Therapy

Zartasha Aftab^{1*}, Syed Muhammad Ahmad Bukhari¹, Muhammad Abubakar², Hafiz Muhammad Sultan¹, Muhammad Zubair¹, Maysoon Ahmed Abou El Niaaj³

¹The Institute of Biological Science, Khwaja Fareed University of Engineering and Information Technology, Rahim Yar Khan, Pakistan

²Academy of Medical Engineering and Translational Medicine, Medical College, Tianjin University, Tianjin 300072, China

³Department of Internal Medicine, Medcare Hospitals and Medical Center, United Arab Emirates

**Corresponding author:* Zartasha Aftab, zartashaaftab429@gmail.com

Copyright: © 2024 Author(s). This is an open-access article distributed under the terms of the Creative Commons Attribution License (CC BY 4.0), permitting distribution and reproduction in any medium, provided the original work is cited.

Abstract: Nanotechnology has far-reaching implications and applications in multiple fields. The biomedical and health sectors can use nanotechnology concepts for medication delivery and treatment. Under controlled conditions, it can target and initiate administering drugs and several other therapeutic agents. Since cancer is the largest cause of death worldwide, prompt diagnosis and effective anticancer treatments are crucial. In this particular context, nanotechnology reduces side effects and directs drug delivery to specifically target cancer cells, providing unique benefits for cancer therapy. In the present thorough review, the most noteworthy new findings for 2010–2023 were compiled, which address the development and use of nanosystems for cancer treatment. Nanoparticles allow precise and controlled release of therapeutic substances at specific action locations, enabling targeted medication delivery. Size, shape, surface, charge, and loading methods impact its efficiency. Researchers have made advancements in encapsulating drugs into nanoliposomes and nanoemulsions, including paclitaxel and fisetin, and are currently testing their suitability in ongoing clinical trials. The purpose of this review is to serve as a continuous path toward recognizing the extraordinary potential of various nanoparticles in cancer therapies.

Keywords: Nanoparticles; Anticancer; Drug delivery; Therapeutics; Medicine

Online publication: November 26, 2024

1. Introduction

According to the 2022 cancer statistics, cancer is one of the major causes of death worldwide ^[1]. When treating

a cancer patient, chemotherapy, radiation, and surgery are the traditional therapeutic choices ^[2]. The disease damages the patient's fitness, which deteriorates with each therapy intervention over time, thereby determining the optimal course of action ^[3]. Other factors include the location and stage of the malignancy ^[3]. While there is a possibility of serious problems and an increased risk of dying from other diseases, these treatments can lower cancer mortality and recurrence rates. For a long time, radiotherapy has been a vital tool in the fight against cancer because it may be able to cure the disease, reduce symptoms, and increase survival ^[4]. However, radiation therapy also carries significant adverse consequences. Radiation therapy not only targets the tumour cells but also damages the surrounding normal tissue ^[5]. Chemotherapy is possible to treat cancer with a wide range of pharmacological classes, but doing so may have unfavorable side effects, including autoimmune-like conditions and potentially fatal adverse events brought on by the reactivation of cellular immunity ^[6].

Numerous scientific disciplines have made significant efforts to mitigate the aforementioned issues by investigating alternatives that avoid the toxicity and adverse effects of traditional medicines. Most of these novel strategies, like using inorganic nanoparticles with altered surfaces to combat cancer, are still undergoing extensive study ^[7]. However, research has demonstrated that they possess significant side effects. Radiation and chemotherapy have two primary drawbacks: their high toxicity to surrounding healthy cells, tissues, and organs, which can result in drug resistance during treatment, and their lack of specificity, which results in insufficient drug delivery at the targeted site ^[8]. To address these issues, the scientific community looks to nanotechnology, which has the potential to improve medicine delivery to target areas while also boosting efficacy and lowering adverse effects ^[9]. As a result, nanoparticles' large specific surface areas give them useful properties, such as the ability to become bio-functionalized and a useful interface that helps the nanoparticles interact with the tissues around them ^[10].

Scientists are creating many products that involve the manufacturing of nanoparticles or their use, and because of their potential efficacy and the need for fewer medications, nanomedicine is becoming a more popular study subject ^[11]. As a result, the application of nanoparticles in this situation may also help to augment, stimulate, or improve the efficacy of medication therapy at a lower cost. Nanoparticles have brought about a paradigm shift in the field of oncological therapy medication delivery ^[12]. Scientists have successfully solved problems related to drug solubility and systemic toxicity ^[13]. This has led to the development of several drug delivery systems based on nanoparticles that are now moving through different stages of clinical research. The intentional incorporation of nanoparticles has greatly enhanced the integration of imaging technologies into the fields of cancer diagnosis and treatment monitoring ^[14]. When sparingly loaded with imaging moieties like gold nanoparticles and quantum dots, these small structures can follow the spread of therapeutic agents in real time and instantly visualize neoplastic tumors ^[15].

The field of nanoparticle research has paid significant attention to the emerging field of "theranostics," an inventive idea that combines therapeutic and diagnostic functions ^[16]. Scientists have cleverly engineered some nanoparticles to fulfill two functions: they can carry drugs and provide useful imaging capabilities simultaneously. Clinical trials are currently thoroughly investigating this dual purpose to enhance the accuracy and effectiveness of cancer therapies ^[17]. Researchers have skillfully applied magnetic nanoparticles in hyperthermia therapy, using alternating magnetic fields to create controlled hyperthermic effects within cancer cells ^[18]. Researchers have conducted clinical trials for specific cancers to assess the therapeutic potential and viability of this approach ^[19].

In addition, nanoparticles have shown enormous promise in increasing the susceptibility of cancer cells

to radiation therapy^[20]. Nanoparticles present the alluring possibility of delivering treatments with unmatched specificity in the field of precision oncology^[21]. Adding ligands to nanoparticles that are specifically made to target cancer cells makes treatments much more effective overall and lowers the damage to healthy tissues^[22]. This paper provides a brief overview of the use of nanoparticles. Nanoparticles typically have dimensions ranging from 1 to 100 nm and exhibit features that are highly dependent on surface area and size. Conversely, researchers have spent more time studying different polymeric nanoparticles and nanoliposomes^[23], which are well-known drug carriers, about cancer treatments. On the other hand, researchers have studied different polymeric nanoparticles and nanoliposomes well-known drug carriers for cancer treatments for a longer period^[24].

Despite numerous attempts, it is challenging to classify nanoparticles systematically due to their variety of forms. Therefore, nanoparticles can be categorized based on their form, average size, chemical makeup, and manufacturing method, among other factors^[25]. Nanoparticles' high surface area-to-volume ratios are useful in a variety of applications mediated by surface phenomena^[26]. When using nanoparticles for medication administration, for instance, specific surface area and surface functionalization are crucial factors to consider^[27]. Their larger surface area allows for the attachment of more anticancer drugs, enhancing their effectiveness as drug delivery vectors. Due to their nanometric size, which allows them to pass across blood-brain barriers, nanoparticles can penetrate pores and aid in the development of more potent treatments for neurological diseases and brain tumours^[28].

One of the many benefits of developing therapeutics at the nanoscale is that nanoparticles can solve anticancer medication solubility and stability issues^[29]. Putting a drug that does not dissolve well in a hydrophilic nanocarrier can help it get to where it needs to go and be used^[30]. This is because water solubility limits bioavailability and slows down the development of new drugs. Nanocarriers or synthetic chemicals must encapsulate antineoplastic medicines to prevent the excretion or breakdown of anticancer compounds^[31]. Additionally, nanotechnology can selectively reroute chemicals to cancer cells or enhance drug penetration and redirection because of its physicochemical characteristics^[32]. Anticancer medicines employ both active and passive targeting strategies in their rerouting^[33]. Furthermore, the quick cargo release of nanocarriers makes nanomedicine treatment stimuli-sensitive. A pH-independent medication can be catenated like doxorubicin into pH-sensitive nanoparticles to enhance cellular absorption and intracellular release. Ultimately, directed nanomedicine treatments decrease the tumor's resistance to anticancer medications^[34]. Targeted input and multidrug-resistant adenosine triphosphate outflow pump-driven excretion generally reduce non-specificity^[35]. Nanomedicine can slow down the rate at which a drug moves through the body, making it easier for stimulus-responsive drugs to get into the body and block the drug's endocytic input^[36].

2. Synthesis of nanoparticle

A variety of techniques can synthesize nanoparticles (NPs), broadly categorized into two classes: the bottom-up approach and the top-down approach.

2.1. Bottom-up synthesis

Bigger molecules undergo a destructive process to break down into smaller components, which then transform into the appropriate nanoparticles^[25]. Various decomposition techniques, such as chemical vapour deposition (CVD), physical vapour deposition (PVD), and grinding and milling, are examples of this

method. For instance, a study employed the milling process to synthesize coconut shell (CS) nanoparticles. Ceramic balls and a planetary mill were used to finely grind raw CS particles for varying durations. Through a variety of characterization methods, the study examined ways the milling duration affected the total size of the nanoparticles. The Scherer equation revealed that the nanoparticles' crystallite size decreased as the milling duration increased ^[37]. Furthermore, the brownish colour diminished with every hour because of the nanoparticles' decreasing size. SEM data supported the X-ray pattern, indicating a reduction in particle size over time ^[38]. Another work used a top-down destructive method to create spherical magnetite nanoparticles from natural iron oxide (Fe₂O₃) ore. When organic oleic acid was present, the particles produced ranged in size from approximately 20 to 50 nm ^[39].

A straightforward top-down method synthesizes colloidal carbon into spherical particles with a controllable size ^[40]. This method was based on the steady chemical adsorption of Polyoxometalates (POM) on the carbon interfacial surface ^[41]. This made the carbon black stick together into smaller, spherical particles that were evenly distributed in size and could spread out easily ^[42]. Micrographs showed that as the sonication period increased, the size of the carbon particles shrank. Transition-metal dichalcogenide nanodots (TMD-NDs) were synthesized from their bulk crystals using a top-down mix of grinding and sonication procedures ^[43]. Nearly all TMD-NDs found with diameters less than 10 nm exhibit excellent dispersion due to their limited size range.

2.2. Top-down synthesis

This method, often known as the “building up” method, entails creating nanoparticles from comparatively simpler materials. This strategy includes techniques for sedimentation and reduction, as well as sol-gel, green synthesis, spinning, and biological synthesis, to synthesize TiO₂ anatase nanoparticles containing graphene domains ^[44]. They used precursors for titanium isopropoxide and alizarin to create a photoactive composite, which catalyzed the breakdown of methylene blue ^[45]. Alizarin was selected because of its potent ability to bind TiO₂ via its axial hydroxyl terminal groups. According to the SEM results, the size of the nanoparticles increases as the temperature rises. A top-down laser irradiation method to successfully make well-uniform spherical Au nanosheets with monocrystalline structures. Recently, the solvent-exchange approach produced limit-sized low-density lipoprotein (LDL) nanoparticles for medical cancer medication administration ^[46]. Nucleation represents the bottom-up approach in this strategy, whereas growth represents the top-up method ^[47].

Researchers have synthesized monodispersed and spherical bismuth (Bi) nanoparticles using both top-down and bottom-up methods, with outstanding colloidal characteristics ^[48]. The top-down approach transformed bismuth into a molten form and then emulsified it within cooked diethylene glycol to make the nanoparticles, while the bottom-up approach boiled bismuth acetate within ethylene glycol ^[48]. The nanoparticles produced by the two techniques ranged in size from 100 nm to 500 nm. Numerous researchers are drawing attention to the feasibility and less harmful nature of green and biogenic bottom-up synthesis methods ^[49]. These procedures are both economical and environmentally benign, as they create nanoparticles using biological systems such as plant extracts, bacteria, yeast, fungi, aloe vera, tamarind, and even human cells. Researchers have synthesized gold nanoparticles from the biomass of wheat and oat, using microorganisms and plant extracts as reducing agents.

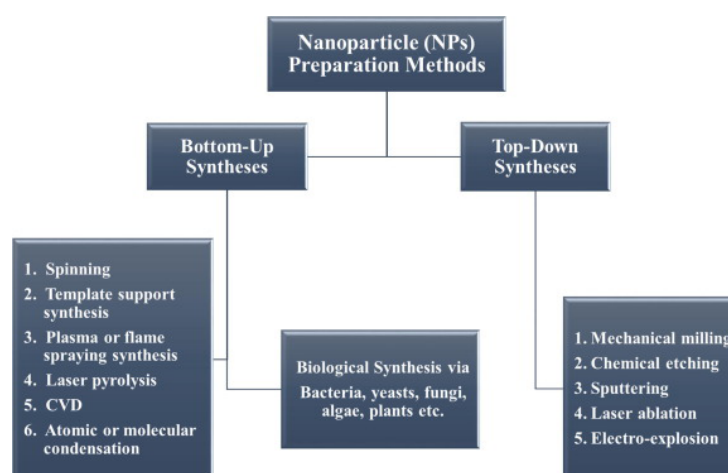


Figure 1. Nanoparticles synthesis approaches, bottom-up and top-down approaches.

Table 1. Bottom-up and top-down approaches merits and demerits

Top-down method	Merits	Demerits
Optical lithography	A trustworthy, well-established micro- or nanofabrication instrument, especially for chip manufacturing, with a high throughput and adequate resolution.	The trade-off between sensitivity and resolution in the resist process necessitates sophisticated, costly, clean room-based procedures.
E-beam lithography	This highly precise technique, often used in research settings, is a useful tool for nanofabrication, enabling the creation of desired-shaped nanostructures as small as 20 nm.	It is expensive, slow (serial writing method), low-throughput, and challenging for nanofabrication below 5 nm.
Scanning probe lithography	Chemicals with high molecular and mechanical resolution Nanopatterning abilities that are precisely regulated. The resists contain nanopatterns for silicon transfer, as well as the ability to manipulate both large molecules and single atoms.	High-throughput applications and production are restricted, and the procedure can be costly, particularly when using ultra-high vacuum scanning probe lithography.
Atomic layer deposition	It achieves atomic-level precision in digital thickness control by creating pinhole-free nanostructured films over vast regions, one atomic layer at a time.	According to the use of many components, this procedure is typically sluggish and costly because it uses many components.
Bottom-up method	Merits	Demerits
Atomic layer deposition	Enables precise atomic-level digital thickness control by depositing single atomic layers at a time; large-scale, pinhole-free nanostructured films; The films exhibit excellent repeatability and adhesion due to the establishment of chemical bonds at the first atomic layer.	It is typically a laborious and costly procedure because vacuum components are involved. It might be challenging to economically deposit some metals, multicomponent oxides, and crucial semiconductors for technology.
Sol gel nanofabrication	Chemical synthesis is a low-cost technique that fabricates a wide range of nanomaterials, including materials with multiple components such as glass, ceramic, film, fiber, and composite materials.	Not readily scalable, it is typically challenging to regulate the synthesis process and the ensuing drying stages.
DNA-scaffolding	The system allows for the highly accurate assembly of nanoscale parts into programmable configurations with far smaller dimensions (less than 10 nm in half-pitch).	A wide range of topics need to be investigated, such as throughput, cost, line edge roughness, compatibility with CMOS fabrication, and innovative unit and integration procedures.
Molecular self-assembly	Nanosystems that are accurate down to the atomic level can be synthesized by stretching patterns very large and letting deep molecular nonpatterns with a width of less than 20 nm form.	Nanosystems are more difficult to design and create than mechanically directed assemblies.

3. Application of nanoparticles

3.1. Application of nanoparticles in medicine

Simple or complex, nano-sized inorganic particles have special physical and chemical characteristics that make them essential building blocks for the creation of innovative nano devices with uses in the physical, biological, biomedical, and pharmaceutical domains ^[50]. Nanoparticles (NPs) are becoming more valuable in medicine because of their capacity to provide medications in the right quantities, increase therapeutic efficacy, lessen adverse effects, and increase patient compliance ^[12]. Biomedical applications frequently employ iron oxide particles such as maghemite (Fe_2O_3) and magnetite (Fe_3O_4) ^[51]. Mie theory and the discrete dipole approximation approach frequently determine their optical characteristics, leading to the use of NPs for biological and cell imaging, as well as photothermal therapy ^[52]. Polyethylene oxide (PEO) and polylactic acid (PLA) nanoparticles (NPs), which are hydrophilic, have shown promise as ways to deliver drugs ^[53]. The use of superparamagnetic iron oxide nanoparticles (NPs) with specific surface chemistry in medication administration, tissue regeneration, immunoassays, hyperthermia, MRI contrast enhancement, and cell separation ^[54]. Antigen-antibody interactions, using labeled antibodies, can detect analyses in tissue slices.

Biodegradable NPs are gaining attention for drug delivery because they can efficiently transport medications while minimizing negative effects. Liposomes are a promising drug carrier, although they have drawbacks such as low stability and low encapsulation efficiency ^[55]. Compared to liposomes, polymeric NPs have improved drug stability and controlled release characteristics. The surface plasmon resonance (SPR) characteristics of semiconductors and metallic nanoparticles make them promising for cancer treatment and detection ^[56]. Multi-hydroxylated NPs have demonstrated antineoplastic action with decreased toxicity, whereas gold nanoparticles can convert absorbed light into localized heat for laser photothermal therapy. Silver nanoparticles are being used more often in home items and wound dressings due to their antibacterial properties ^[57]. Functionalized TiO_2 , ZnO , BiVO_4 , Cu-, and Ni-based NPs specifically target microbial species in textiles, medicine, water disinfection, and food packaging.

3.2. Application of nanoparticles in anticancer activity

The current difficulties in treating cancer with traditional medicines have led to further advancements in nanotechnology. The exponential growth of nanoscience has led to the development of therapeutically active nanomaterials (NMs) ^[58]. They have great potential in cancer treatment because NMs alter the profile of medication toxicity. Improved surface properties enable nanoparticles (NPs) to diffuse more readily within tumor cells, minimizing toxicity and delivering the right medication dosage to the tumor site ^[59]. Using NMs with tumor-specific components, it overcomes the challenges of the anticancer agent's indiscriminate biodistribution and excessive dosage administration by targeting cancer cells ^[28]. This article focuses on the most recent developments in the application of different nanomaterials to cancer treatment, including their ability to target organelles, tumor microenvironment (TME), and cancer cell surfaces ^[59]. Nano routes are transforming the paradigm of cancer management through the distribution of anticancer drugs.

3.3. Application of nanoparticles in drug delivery

Nanoparticles, typically in the size range of 1–100 nanometers, are minuscule particles that can encapsulate therapeutic agents such as small molecules, proteins, peptides, or nucleic acids ^[60]. Protein and polysaccharides are used as nanomaterials for the formation of composite scaffolds that have favorable properties to use ^[61].

They represent a state-of-the-art technology in drug delivery, carrying many advantages over traditional drug formulations. Nanoparticles can functionalize targeting ligands like aptamers, peptides, or antibodies to identify and attach to specific cells or tissues. This precise delivery of medications to the intended site of action minimizes side effects and enhances therapeutic efficiency ^[62].

Although initially developed to serve as vaccination and chemotherapy agent carriers, nanoparticles are stable, solid particles composed of degradable polymers that range in size from 10 to 1000 nm. Medicinal substances can become enmeshed in the particle matrix, adhere to the particle surface, and become trapped in the polymer ^[63]. Oncology is the primary field of study for most of the research on using nanoparticles as a medicine delivery mechanism ^[64]. In addition to enhancing retention and permeability, nanoparticles can concentrate in tumour masses, inflammatory areas, and infection sites. While it is also feasible to produce multiple unique medications and selectively administer that particular medication to the cancerous tissue, a colloidal shell encases a cancer-fighting medication, which breaks down over time, while a lipid layer encases an antiangiogenesis medication ^[65]. When injected intravenously, the cancer cells absorb this nanoparticle. The first action of the antiangiogenesis medication is to inhibit the intermediaries involved in blood vessel formation. The release of the anti-cancer medication subsequently leads to the effective elimination of cancer cells ^[66]. A nanoscale, an effective vehicle for the anticancer medication to reach the neoplastic location, enables all of that.

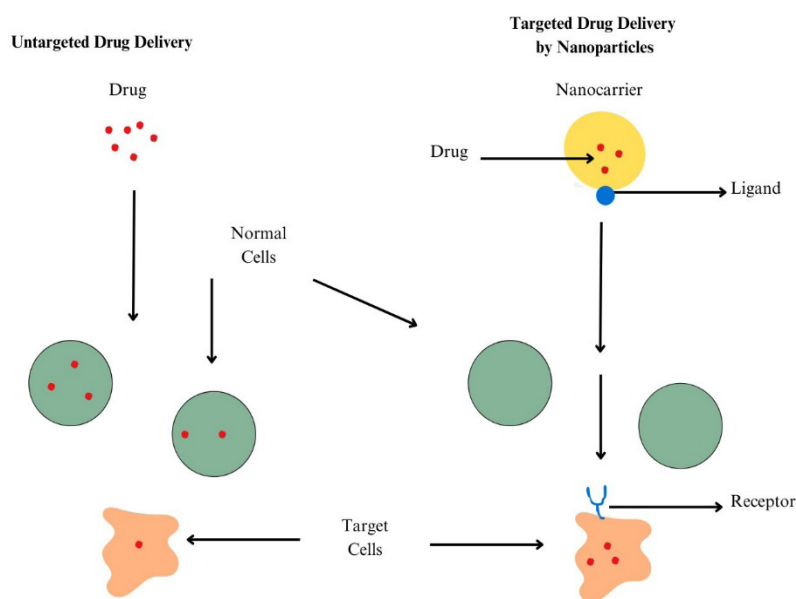


Figure 2. Untargeted drug delivery (left) and targeted drug delivery by nanoparticles (right)

Nanoparticles can release medications in a regulated manner, either continuously for an extended period or in response to specific stimuli such as pH, temperature, enzymes, or light ^[67]. This controlled release profile allows for the maintenance of therapeutic medication levels within the intended range, thereby maximizing effectiveness and minimizing side effects ^[68]. The poor solubility and bioavailability of many medications, particularly hydrophobic chemicals, limit their therapeutic effectiveness. Nanoparticles can encapsulate these medications, protecting them from deterioration, and enhancing their solubility and durability in physiological settings ^[69]. Due to this increased bioavailability, better drug absorption and distribution translate into greater therapeutic results. The protective shell that nanoparticles provide shields the encapsulated medicine from

enzyme breakdown and adverse environmental conditions ^[70]. This defense strengthens the medication's stability throughout the body's circulation, extending its half-life and enabling prolonged release at the intended location. By delivering many medications at once that have distinct physicochemical characteristics, nanoparticles can overcome drug resistance and produce synergistic benefits ^[71]. This strategy is especially helpful for treating complicated illnesses like cancer, as combination therapies that target several pathways can increase efficacy and lower the chance of tumor recurrence. By delivering pharmaceuticals directly to the target site and minimizing systemic exposure, nanoparticles can lessen the toxicity associated with traditional therapeutic formulations ^[72]. This targeted delivery enhances the therapeutic intervention's safety profile by reducing the likelihood of off-target effects on healthy tissues. Nanoparticles offer the possibility of personalized medical techniques by enabling customized drug delivery plans based on unique patient features ^[73]. This personalization can result in therapeutic interventions that are more patient-centered and effective, maximizing therapy efficacy while minimizing side effects.

Table 2. List of different types of nanoparticles with their composition and applications ^[66]

Types of nanoparticles	Composition	Applications
Solid lipid nanoparticles	Melted lipid diffused in aqueous surfactant	A less toxic and extra firm colloidal carrier as substitute substance to polymer
Polymeric nanoparticles	Decomposable polymer	regulated and targeted delivery of drugs
Polymeric micelles	Amphiphilic block copolymer	regulated and organized delivery of hydrophobic drugs
Magnetic nanoparticles	Magnetite Fe ₂ O ₃ , Meghe mite covered with dextran	Drug for targeting diagnostics in medication
Carbon nanoparticles	Metals, semiconductors or carbon	Regulated transfer of drug to DNA and gene
Liposomes	Phospholipid vesicles	Regulated delivery of drug
Nanoshells	Dielectric core and metal shell	Targeted drug delivery to tumor
Ceramic nanoparticles	Silica, alumina, titania	Delivery of drugs and biomolecules
Nanopores	Aerogel, which is created by cell gel chemistry	Carriers for focused drug release
Nanowires	Silicon, cobalt, gold or copper-based nanowires	Carries electrons in nanoelectronics

3.4. Applications of nanoparticles as therapeutic agents

Nanoparticles themselves can serve as therapeutic agents due to their unique qualities and abilities ^[74]. This makes them excellent options for a range of medical applications. Copper, zinc oxide, and silver nanoparticles possess intrinsic antibacterial qualities ^[74]. They can damage microbial membranes, stop enzyme function, and produce reactive oxygen species, which can effectively kill or stop the growth of viruses, fungi, and bacteria ^[57]. These antimicrobial nanoparticles have potential uses in medical implants, wound dressings, and anti-infection surface coatings. It is possible to create nanoparticles so that they reduce the body's inflammatory reactions. As an example, gold nanoparticles that are coated with peptides or anti-inflammatory drugs can target tissues that are inflamed and stop the pathways that cause inflammation ^[75]. This could help treat asthma, inflammatory bowel disease, and rheumatoid arthritis. Researchers are thoroughly studying the potential of nanoparticles in cancer therapy. Functions can be added to different kinds of nanoparticles, like liposomes, polymeric nanoparticles, and inorganic nanoparticles, so they can only reach tumor cells and deliver photothermal agents, nucleic acids, or chemotherapeutic medicines ^[76]. These nanoparticles can improve the effectiveness of anticancer drugs and reduce side effects by breaking down multidrug resistance, making it easier for drugs

to build up at the site of the tumor, and making combination therapy more possible. For neurodegenerative illnesses like Alzheimer's, Parkinson's, and stroke, nanoparticles exhibit promise in neuroprotection and neurodegeneration treatments^[77]. Putting nanoparticles into the central nervous system that contain growth factors, neuroprotective drugs, or stem cells can help neurons survive, heal damaged tissue, and improve functional recovery. Researchers are exploring the use of cardiovascular nanoparticles in the treatment of various cardiovascular illnesses such as atherosclerosis^[78], myocardial infarction, and thrombosis. Nanoparticles functionalized with antioxidants, thrombolytic medications, or anti-inflammatory medicines can target plaque deposits, reduce inflammation, and dissolve blood clots, thereby treating or preventing cardiovascular events. These useful instruments for immunotherapy applications have the ability to alter the body's immunological responses^[75]. Nanoparticles can be engineered to carry adjuvants, immune checkpoint inhibitors, or antigens that can activate or deactivate specific immune pathways. This could lead to new treatments for autoimmune diseases, allergies, and cancer immunotherapy^[79].

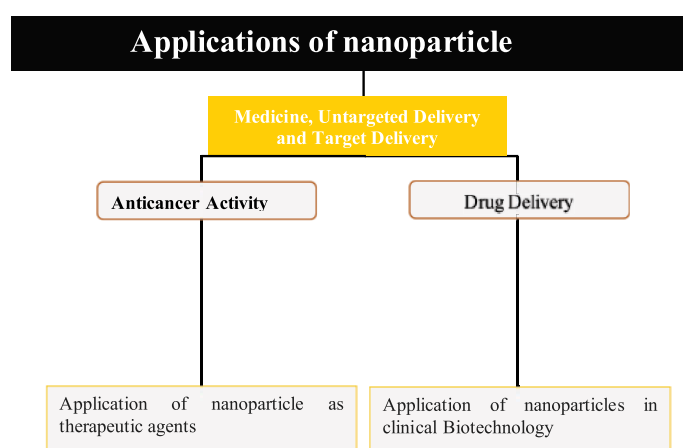


Figure 3. Schematic representation of applications of nanoparticles in anticancer activity and drug delivery.

4. Usage in clinical settings

Researchers have thoroughly studied NPs for their potentially beneficial anticancer effects in a variety of human cancer cell lines, including MDA-MB-231 breast cancer cells, IMR-90 lung fibroblasts, endothelial cells, and U251 glioblastoma cells^[80]. NPs demonstrated considerable potential as efficient drug delivery methods against tumors. Traditional cancer therapies like radiotherapy, chemotherapy, and surgery have established drawbacks such as drug toxicity, erratic side effects, issues with drug resistance, and a lack of specificity^[81]. NPs overcome these drawbacks by reducing side effects and improving cancer therapy effectiveness. One of their unique selling points is their ability to administer medications with precision and traverse various biologic barriers. The combination of targeted delivery of anticancer medications to tumor tissues and green manufacturing of NPs is a novel strategy for enhancing cancer treatment^[82]. One of the most intriguing and difficult methods available today for efficient, tailored cancer treatment is theranostics, which combines diagnostics and therapy^[83]. NPs can create scattering lights for imaging when they selectively absorb into malignant cells^[84]. Despite their proven effectiveness in dental treatment, NPs continue to be a contentious candidate because of their inconsistent toxicity in biological systems. It is interesting to note that NPs have shown encouraging action against the malaria pathogen *Plasmodium falciparum* as well as its associated vector,

the female *Anopheles* mosquito. In oral, cutaneous, and inhalational exposures, NP bioavailability is low; nevertheless, it varies according to the particle size, dosage, surface coating, and soluble fraction ^[85].

Table 3. List of nanoparticles with their neurotoxic effects ^[66]

Nanoparticles	Neurotoxic effects
Carbon nanotubes	It initiates the synthesis of reactive oxygen species, escalate oxidative stress, restrain cell growth, and cause apoptosis.
Silver nanoparticles	It causes a decline in the anti-oxidation capability of anti-oxidative enzymes and escalate oxidative stress.
Titanium oxide nanoparticles	It initiates oxidative stress, causes inflammation of neurons, cause genotoxicity, imbalance neurotransmitters, and suppress signaling pathways.
Iron oxide nanoparticles	It causes inflammation of neurons, apoptosis, and the infiltration of immune cells.
Silica	It causes intellectual disruption, synapse alterations, and increases oxidative stress.
Organic nanoparticles	It causes oxidative stress, inflammation and apoptosis in nerve cells.

5. Future and challenges

Even with all of the recent improvements in cancer care, it is still one of the leading causes of death worldwide. Past research revealed that traditional therapy approaches can have a plethora of unintended consequences. As a result, researchers are trying to come up with new approaches to cancer diagnosis and therapy. The pharmaceutical industry has recently given a lot of attention to the green synthesis of NPs ^[86]. Although green chemistry is, non-toxic, inexpensive, and ecologically benign, biologic approaches have certain drawbacks. NPs' high levels of biodegradability and clearance are also essential for preventing any potential long-term toxicity ^[87]. When it came to treatments based on nanomedicine, NPs demonstrated enormous promise.

However, clinical trials are necessary to determine the future use of NPs-based nanomedicine. Clinical studies need to resolve the main issues of biodegradability, dosage, and mode of administration. Additionally, NPs can be a crucial imaging and detection tool for cancer cells in the early phases of cancer diagnosis ^[88]. It has already been demonstrated that the green production of NPs aids *in vivo* fluorescent tumor imaging. The use of green-synthesized NPs will be anticipated as a potential cancer treatment and diagnostic tool in the future era of cancer treatment.

6. Conclusion

This paper provides an extensive overview of nanoparticles (NPs), including information on their types, synthesis techniques, characterizations, physicochemical characteristics, and applications. Several characterization methods, including SEM, TEM, and XRD, have demonstrated that NPs have a shape that can be controlled and range in size from a few nanometers to 500 nm. Their small size and large surface area allow for a variety of applications. Their optical characteristics also become more significant at the nanoscale, increasing their importance in photocatalytic applications. Synthetic approaches can achieve the controllable morphology, size, and magnetic properties of nanoparticles (NPs), thereby enabling their adaptability in diverse sectors. Nevertheless, concerns about the health risks associated with the careless use and release of NPs into the environment persist, despite their benefits. Resolving these issues is imperative to ensure the safe and

ecologically responsible use of NPs.

Author contribution

Conceptualization: Zartasha Aftab

Investigation: Zartasha Aftab, Syed Muhammad Ahmad Bukhari, Muhammad Abubakar, Hafiz Muhammad Sultan

Writing – original draft: Zartasha Aftab, Syed Muhammad Ahmad Bukhari, Hafiz Muhammad Sultan, Muhammad Zubair

Writing – review & editing: all authors

Visualization: Maysoon Ahmed Abou El Niaaj

Disclosure statement

The authors declare no conflict of interest.

References

- [1] Bray F, Laversanne M, Sung H, et al., 2024, Global Cancer Statistics 2022: GLOBOCAN Estimates of Incidence and Mortality Worldwide for 36 Cancers in 185 Countries. *CA: A Cancer Journal for Clinicians*, 74(3): 229–263.
- [2] Feria A, Times M, 2024, Effectiveness of Standard Treatment for Stage 4 Colorectal Cancer: Traditional Management with Surgery, Radiation, and Chemotherapy. *Clinics in Colon and Rectal Surgery*, 37(2): 62–65.
- [3] Engelhardt M, Ihorst G, Duque-Afonso J, et al., 2020, Structured Assessment of Frailty in Multiple Myeloma as a Paradigm of Individualized Treatment Algorithms in Cancer Patients at Advanced Age. *Haematologica*, 105(5): 1183.
- [4] Olivares-Urbano MA, Griñán-Lisón C, Marchal JA, et al., 2020, CSC Radioresistance: A Therapeutic Challenge to Improve Radiotherapy Effectiveness in Cancer. *Cells*, 9(7): 1651.
- [5] Dilalla V, Chaput G, Williams T, et al., 2020, Radiotherapy Side Effects: Integrating a Survivorship Clinical Lens to Better Serve Patients. *Current Oncology*, 27(2): 107–112.
- [6] Anand U, Dey A, Chandel AKS, et al., 2023, Cancer Chemotherapy and Beyond: Current Status, Drug Candidates, Associated Risks and Progress in Targeted Therapeutics. *Genes & Diseases*, 10(4): 1367–1401.
- [7] Magro M, Venerando A, Macone A, et al., 2020, Nanotechnology-Based Strategies to Develop New Anticancer Therapies. *Biomedicine*, 10(5): 735.
- [8] De Ruysscher D, Niedermann G, Burnet NG, et al., 2019, Radiotherapy Toxicity. *Nature Reviews Disease Primers*, 5(1): 13.
- [9] Haleem A, Javaid M, Singh RP, et al., 2023, Applications of Nanotechnology in the Medical Field: A Brief Review. *Global Health Journal*, 7(2): 70–77.
- [10] Sanità G, Carrese B, Lamberti A, 2020, Nanoparticle Surface Functionalization: How to Improve Biocompatibility and Cellular Internalization. *Frontiers in Molecular Biosciences*, 7: 587012.
- [11] Farjadian F, Ghasemi A, Gohari O, et al., 2019, Nanopharmaceuticals and Nanomedicines Currently on the Market: Challenges and Opportunities. *Nanomedicine*, 14(1): 93–126.
- [12] Joseph TM, Mahapatra DK, Esmaeili A, et al., 2023, Nanoparticles: Taking a Unique Position in Medicine. *Nanomedicine*, 13(3): 574.

- [13] Neal JM, Barrington MJ, Fettiplace MR, et al., 2018, The Third American Society of Regional Anesthesia and Pain Medicine Practice Advisory on Local Anesthetic Systemic Toxicity: Executive Summary 2017. *Regional Anesthesia and Pain Medicine*, 43(2): 113–123.
- [14] Wang C, Fan W, Zhang Z, et al., 2019, Advanced Nanotechnology Leading the Way to Multimodal Imaging-Guided Precision Surgical Therapy. *Advanced Materials*, 31(49): 1904329.
- [15] Siddique S, Chow JC, 2020, Gold Nanoparticles for Drug Delivery and Cancer Therapy. *Applied Sciences*, 10(11): 3824.
- [16] Alshehri S, Imam SS, Rizwanullah M, et al., 2020, Progress of Cancer Nanotechnology as Diagnostics, Therapeutics, and Theranostics Nanomedicine: Preclinical Promise and Translational Challenges. *Pharmaceutics*, 13(1): 24.
- [17] Booth CM, Karim S, Mackillop WJ, 2019, Real-World Data: Towards Achieving the Achievable in Cancer Care. *Nature Reviews Clinical Oncology*, 16(5): 312–325.
- [18] Joshi R, Perala RS, Srivastava M, et al., 2019, Heat Generation from Magnetic Fluids Under Alternating Current Magnetic Field or Induction Coil for Hyperthermia-Based Cancer Therapy: Basic Principle. *Journal of Research and Cancer*, 10(4): 156–164.
- [19] Golovin YI, Zhigachev A, Efremova M, et al., 2018, Ways and Methods for Controlling Biomolecular Structures Using Magnetic Nanoparticles Activated by an Alternating Magnetic Field. *Nanotechnology in Research*, 13: 295–304.
- [20] Shen H, Huang H, Jiang Z, 2023, Nanoparticle-Based Radiosensitization Strategies for Improving Radiation Therapy. *Frontiers in Physics*, 14: 1145551.
- [21] Kuncic Z, Lacombe S, 2018, Nanoparticle Radio-Enhancement: Principles, Progress and Application to Cancer Treatment. *Physics in Medicine and Biology*, 63(2): 02TR01.
- [22] Tian H, Zhang T, Qin S, et al., 2022, Enhancing the Therapeutic Efficacy of Nanoparticles for Cancer Treatment Using Versatile Targeted Strategies. *Oncology*, 15(1): 132.
- [23] Bilal M, Qindeel M, Raza A, et al., 2021, Stimuli-Responsive Nanoliposomes as Prospective Nanocarriers for Targeted Drug Delivery. *Journal of Drug Delivery Science and Technology*, 66: 102916.
- [24] Silva CO, Pinho JO, Lopes JM, et al., 2019, Current Trends in Cancer Nanotheranostics: Metallic, Polymeric, and Lipid-Based Systems. *Pharmaceutics*, 11(1): 22.
- [25] Khan Y, Sadia H, Ali Shah SZ, et al., 2022, Classification, Synthetic, and Characterization Approaches to Nanoparticles, and Their Applications in Various Fields of Nanotechnology: A Review. *Cancers*, 12(11): 1386.
- [26] Joudeh N, Linke D, 2022, Nanoparticle Classification, Physicochemical Properties, Characterization, and Applications: A Comprehensive Review for Biologists. *Journal of Nanobiotechnology*, 20(1): 262.
- [27] Ijaz I, Gilani E, Nazir A, et al., 2020, Detailed Review on Chemical, Physical and Green Synthesis, Classification, Characterizations and Applications of Nanoparticles. *Green Chemistry Letters and Reviews*, 13(3): 223–245.
- [28] Tao Y, Lan X, Zhang Y, et al., 2022, Navigations of the Targeting Pathway of Nanomedicines Toward Tumor. *Expert Opinion on Drug Delivery*, 19(8): 985–996.
- [29] Halwani AA, 2022, Development of Pharmaceutical Nanomedicines: From the Bench to the Market. *Pharmaceutics*, 14(1): 106.
- [30] Qi J, Hu X, Dong X, et al., 2019, Towards More Accurate Bioimaging of Drug Nanocarriers: Turning Aggregation-Caused Quenching into a Useful Tool. *Advanced Drug Delivery Reviews*, 143: 206–225.
- [31] Alqosaibi AI, 2022, Nanocarriers for Anticancer Drugs: Challenges and Perspectives. *Saudi Journal of Biological Sciences*, 29(6): 103298.
- [32] Gao S, Yang X, Xu J, et al., 2021, Nanotechnology for Boosting Cancer Immunotherapy and Remodeling Tumor

Microenvironment: The Horizons in Cancer Treatment. *ACS Nano*, 15(8): 12567–12603.

- [33] Mahmoudian M, Salatin S, Khosroushahi AY, 2018, Natural Low-and High-Density Lipoproteins as Mighty Bio-Nanocarriers for Anticancer Drug Delivery. *Current Cancer Drug Targets*, 82: 371–382.
- [34] Haider M, Elsherbeny A, Pittalà V, et al., 2022, Nanomedicine Strategies for Management of Drug Resistance in Lung Cancer. *International Journal of Molecular Sciences*, 23(3): 1853.
- [35] Gote V, Nookala AR, Bolla PK, et al., 2021, Drug Resistance in Metastatic Breast Cancer: Tumor Targeted Nanomedicine to the Rescue. *International Journal of Molecular Sciences*, 22(9): 4673.
- [36] Meel RVD, Sulheim E, Shi Y, et al., 2019, Smart Cancer Nanomedicine. *Nature Nanotechnology*, 14(11): 1007–1017.
- [37] Singh J, Sharma S, Soni S, et al., 2019, Influence of Different Milling Media on Structural, Morphological and Optical Properties of the ZnO Nanoparticles Synthesized by Ball Milling Process. *Materials Science in Semiconductor Processing*, 98: 29–38.
- [38] Nath D, Singh F, Das R, et al., 2020, X-Ray Diffraction Analysis by Williamson-Hall, Halder-Wagner and Size-Strain Plot Methods of CdSe Nanoparticles: A Comparative Study. *Materials Chemistry and Physics*, 239: 122021.
- [39] Ansari SM, Sinha BB, Phase D, et al., 2019, Particle Size, Morphology, and Chemical Composition Controlled CoFe₂O₄ Nanoparticles with Tunable Magnetic Properties via Oleic Acid Based Solvothermal Synthesis for Application in Electronic Devices. *Applied Applied Nanomaterials*, 2(4): 1828–1843.
- [40] Bhosale SR, Bhosale RR, Jagadhane KS, et al., 2023, Recent Trends in Synthetic Top-Down Approach for Mesoporous Carbon: A Seminal Review. *Journal of Mesoporous Nanomaterials*, 10(1): 601–601.
- [41] D’Cruz B, Amin MO, Al-Hetlani E, 2021, Polyoxometalate-Based Materials for the Removal of Contaminants from Wastewater: A Review. *Industrial and Engineering Chemistry Research*, 60(30): 10960–10977.
- [42] Khodabakhshi S, Fulvio PF, Andreoli E, 2020, Carbon Black Reborn: Structure and Chemistry for Renewable Energy Harnessing. *Carbon*, 162: 604–649.
- [43] Azam A, Yang J, Li W, et al., 2023, Tungsten Diselenides (WSe₂) Quantum Dots: Fundamental, Properties, Synthesis, and Applications. *Progress in Materials Science*, 132: 101042.
- [44] Shoyiga HO, Martincigh BS, Nyamori VO, 2021, Hydrothermal Synthesis of Reduced Graphene Oxide-Anatase Titania Nanocomposites for Dual Application in Organic Solar Cells. *International Journal of Energy Research*, 45(5): 7293–7314.
- [45] Padmanabhan NT, Thomas N, Louis J, et al., 2021, Graphene Coupled TiO₂ Photocatalysts for Environmental Applications: A Review. *Catalysis*, 271: 129506.
- [46] Rajeshkumar S, Lakshmi T, 2021, Green Synthesis of Gold Nanoparticles using *Kalanchoe pinnata* and its Free Radical Scavenging Activity. *International Journal of Dentistry and Oral Science*, 8(7): 2981–2984.
- [47] Samal R, Rout CS, 2020, Recent Developments on Emerging Properties, Growth Approaches, and Advanced Applications of Metallic 2D Layered Vanadium Dichalcogenides. *Advanced Materials Interfaces*, 7(8): 1901682.
- [48] Mourdikoudis S, Sofer Z, 2021, Colloidal Chemical Bottom-Up Synthesis Routes of Pnictogen (As, Sb, Bi) Nanostructures with Tailored Properties and Applications: A Summary of the State of the Art and Main Insights. *Chemistry*, 23(45): 7876–7898.
- [49] Tripathy S, Rodrigues J, Shimpi NG, 2023, Top-Down and Bottom-Up Approaches for Synthesis of Nanoparticles. *Nanoparticle Formation Mechanisms and Its Targeted Diseases*, 145: 92–130.
- [50] Palit S, Hussain CM, 2020, Nanodevices Applications and Recent Advancements in Nanotechnology and the Global Pharmaceutical Industry. *Nanomaterials in Diagnostic Tools and Devices*, Elsevier, Amsterdam, 395–415.
- [51] Yusefi M, Shameli K, Jumaat AF, 2020, Preparation and Properties of Magnetic Iron Oxide Nanoparticles for

- Biomedical Applications: A Brief Review. *Journal of Advanced Research in Materials Science*, 75(1): 10–18.
- [52] Ansari K, Ahmad R, Tanweer MS, et al., 2024, Magnetic Iron Oxide Nanoparticles as a Tool for the Advancement of Biomedical and Environmental Application: A Review. *Biomaterials and Devices*, 2(1): 139–157.
- [53] Liu S, Qin S, He M, et al., 2020, Current Applications of Poly (Lactic Acid) Composites in Tissue Engineering and Drug Delivery. *Chemical Physics and Biophysical Engineering*, 199: 108238.
- [54] Montiel Schneider MG, Martín MJ, Otarola J, et al., 2022, Biomedical Applications of Iron Oxide Nanoparticles: Current Insights, Progress, and Perspectives. *Pharmaceuticals*, 14(1): 204.
- [55] Guimarães D, Cavaco-Paulo A, Nogueira E, 2021, Design of Liposomes as Drug Delivery System for Therapeutic Applications. *International Journal of Pharmaceutics*, 601: 120571.
- [56] Gonzalez Gomez A, Hosseinidoust Z, 2020, Liposomes for Antibiotic Encapsulation and Delivery. *Advances in Drug Delivery*, 6(5): 896–908.
- [57] Hamad A, Khashan KS, Hadi A, 2020, Silver Nanoparticles and Silver Ions as Potential Antibacterial Agents. *Journal of Inorganic Polymers and Materials*, 30(12): 4811–4828.
- [58] Samuel MS, Ravikumar M, John JA, et al., 2022, A Review on Green Synthesis of Nanoparticles and Their Diverse Biomedical and Environmental Applications. *Chemistry*, 12(5): 459.
- [59] Yousaf A, Tasneem N, Mustafa A, et al., 2021, Gastric Cancer Associated Risk Factors and Prevalence in Pakistan. *ASEAN Journal of Science and Engineering*, 1(2): 73–78.
- [60] Yetisgin AA, Cetinel S, Zuvin M, et al., 2020, Therapeutic Nanoparticles and Their Targeted Delivery Applications. *Molecules*, 25(9): 2193.
- [61] Sultan H, 2021, Protein and Polysaccharide Base Biomaterial for the Formation of Composite Bone Scaffold. *AlQalam Journal of Medical and Applied Sciences*, 4(2): 80–88.
- [62] Fu Z, Xiang J, 2020, Aptamer-functionalized Nanoparticles in Targeted Delivery and Cancer Therapy. *International Journal of Molecular Sciences*, 21(23): 9123.
- [63] Marques A, Costa P, Velho S, et al., 2020, Functionalizing Nanoparticles with Cancer-targeting Antibodies: A Comparison of Strategies. *Journal of Controlled Release*, 320: 180–200.
- [64] Gavas S, Quazi S, Karpinski TM, 2021, Nanoparticles for Cancer Therapy: Current Progress and Challenges. *Nanomedicine Reviews Letters*, 16(1): 173.
- [65] Hari SK, Gauba A, Shrivastava N, et al., 2023, Polymeric Micelles and Cancer Therapy: An Ingenious Multimodal Tumor-targeted Drug Delivery System. *Drug Delivery and Translational Research*, 13(1): 135–163.
- [66] Riaz M, Zubair M, Iqbal MK, et al., 2024, Exploring the Platelet and Cancer Cell Interaction in Metastasis Targeting: Platelets and Cancer Cell Interaction. *Journal of Clinical Oncology and Medical Sciences*, 4: 834–844.
- [67] Lavrador P, Esteves MR, Gaspar VM, et al., 2021, Stimuli-responsive Nanocomposite Hydrogels for Biomedical Applications. *Advanced Functional Materials*, 31(8): 2005941.
- [68] Adepu S, Ramakrishna S, 2021, Controlled Drug Delivery Systems: Current Status and Future Directions. *Materials*, 26(19): 5905.
- [69] Sánchez A, Mejía SP, Orozco J, 2020, Recent Advances in Polymeric Nanoparticle-encapsulated Drugs Against Intracellular Infections. *Materials*, 25(16): 3760.
- [70] Ahmed U, Abubakar M, Khan SS, et al., 2024, Long Non-coding RNA and Progression of Breast Cancer. *Oncology Treatment Discovery*, 2(3): 38–64.
- [71] Yao Y, Zhou Y, Liu L, et al., 2020, Nanoparticle-based Drug Delivery in Cancer Therapy and Its Role in Overcoming Drug Resistance. *Frontiers in Molecular Biology*, 7: 193.

- [72] Alghamdi MA, Fallica AN, Virzi N, et al., 2022, The Promise of Nanotechnology in Personalized Medicine. *Journal of Personalized Medicine*, 12(5): 673.
- [73] Mitchell MJ, Billingsley MM, Haley RM, et al., 2021, Engineering Precision Nanoparticles for Drug Delivery. *Nature Reviews Drug Discovery*, 20(2): 101–124.
- [74] Ullah MW, Manan S, Khattak WA, et al., 2020, Biotemplate-mediated Green Synthesis and Applications of Nanomaterials. *Current Pharmaceutical Design*, 26(45): 5819–5836.
- [75] Abubakar M, Bukhari SMA, Mustfa W, et al., 2024, Skin Cancer and Human Papillomavirus. *Journal of Pharmacology*, 31(2): 790–816.
- [76] Rehman B, Abubakar M, Kiani MN, et al., 2024, Analysis of Genetic Alterations in TP53 Gene in Breast Cancer: A Secondary Publication. *Proceedings of Anticancer Research*, 8(3): 25–35.
- [77] Riaz MA, Abubakar M, Ayyoub R, et al., 2024, Expression Analysis of Caspase-3 (CASP3) Gene in Leukemia Patients Using Quantitative Polymerase Chain Reaction (qPCR) and Western Blot Techniques. *Journal of Cancer Biomolecules and Therapeutics*, 1(2): 10–16.
- [78] Pala R, Anju V, Dyavaiah M, et al., 2020, Nanoparticle-mediated Drug Delivery for the Treatment of Cardiovascular Diseases. *International Journal of Nanomedicine*, 15: 3741–3769.
- [79] Yousaf A, Tasneem N, Mustafa A, et al., 2021, Gastric Cancer Associated Risk Factors and Prevalence in Pakistan. *Engineering*, 1(2): 73–78.
- [80] Gurunathan S, Park JH, Han JW, et al., 2015, Comparative Assessment of the Apoptotic Potential of Silver Nanoparticles Synthesized by *Bacillus tequilensis* and *Calocybe indica* in MDA-MB-231 Human Breast Cancer Cells: Targeting p53 for Anticancer Therapy. *International Journal of Nanomedicine*, 10(1): 4203–4223.
- [81] Kang Y, Datta P, Shanmughapriya S, et al., 2020, 3D Bioprinting of Tumor Models for Cancer Research. *Applied Adhesion and Biomechanics*, 3(9): 5552–5573.
- [82] Ma Z, Fan Y, Wu Y, et al., 2019, Traditional Chinese Medicine-Combination Therapies Utilizing Nanotechnology-Based Targeted Delivery Systems: A New Strategy for Antitumor Treatment. *International Journal of Nanomedicine*, 22(14): 2029–2053.
- [83] Tabish TA, Dey P, Mosca S, et al., 2020, Smart Gold Nanostructures for Light-Mediated Cancer Theranostics: Combining Optical Diagnostics with Photothermal Therapy. *Advanced Science*, 7(15): 1903441.
- [84] Wang Y, Xu S, Shi L, et al., 2021, Cancer-cell-Activated In Situ Synthesis of Mitochondria-Targeting AIE Photosensitizer for Precise Photodynamic Therapy. *Angewandte Chemie International Edition*, 60(27): 14945–14953.
- [85] Ferdous Z, Nemmar A, 2020, Health Impact of Silver Nanoparticles: A Review of the Biodistribution and Toxicity Following Various Routes of Exposure. *International Journal of Molecular Sciences*, 21(7): 2375.
- [86] Gour A, Jain NK, 2019, Advances in Green Synthesis of Nanoparticles, *Advanced Chemistry. Nanomedicine, and Biotechnology*, 47(1): 844–851.
- [87] Ying S, Guan Z, Ofoegbu PC, et al., 2022, Green Synthesis of Nanoparticles: Current Developments and Limitations. *Innovation*, 26: 102336.
- [88] Wen H, Jung H, Li X, 2015, Drug Delivery Approaches in Addressing Clinical Pharmacology-Related Issues: Opportunities and Challenges. *Therapeutic Advances Journal*, 17: 1327–1340.

Publisher's note

Bio-Byword Scientific Publishing remains neutral with regard to jurisdictional claims in published maps and institutional affiliations.

Analysis of Factors Affecting Non-Invasive Ventilation Failure in AECOPD Patients with Type II Respiratory Failure

Huijun Li*, Kui Sheng, Zhaoshuang Lu, Ruixiang Zhou, Weizhong Wu, Jinling Gao, Hongying Chu, Dongyang Chen

Gaoyou People's Hospital, Yangzhou 225600, Jiangsu Province, China

*Corresponding author: Huijun Li, diandian0908@163.com

Copyright: © 2024 Author(s). This is an open-access article distributed under the terms of the Creative Commons Attribution License (CC BY 4.0), permitting distribution and reproduction in any medium, provided the original work is cited.

Abstract: *Objective:* To analyze key factors associated with the failure of non-invasive ventilation (NIV) in patients with acute exacerbations of chronic obstructive pulmonary disease (AECOPD) complicated by type II respiratory failure. *Methods:* A total of 122 patients with AECOPD and type II respiratory failure admitted to Gaoyou People's Hospital between January 2020 and June 2023 were selected for the study. Upon admission, all patients received ECG monitoring and NIV, along with comprehensive therapies such as anti-infective treatment, antispasmodics, bronchodilators, and expectorants. NIV was provided using the S/T mode, with ventilator parameters adjusted based on the patient's respiratory status and blood gas analysis results. Clinical data were retrospectively analyzed from electronic medical records. *Results:* Out of the 122 patients, 30 experienced NIV failure, accounting for 24.59%. Significant differences were observed in C-reactive protein (CRP), pH, and partial pressure of arterial carbon dioxide (PaCO₂) between patients with successful and failed NIV outcomes ($P < 0.05$). There were no statistically significant differences in gender, age, arterial oxygen partial pressure (PaO₂), neutrophil count (NEUT), procalcitonin (PCT), albumin (ALB), or tidal volume between the two groups ($P > 0.05$). Logistic regression analysis confirmed that CRP, pH, and PaCO₂ were significant risk factors for NIV failure ($P < 0.05$). *Conclusion:* CRP, pH, and PaCO₂ are independent risk factors influencing NIV failure.

Keywords: Type II respiratory failure; Acute exacerbations of chronic obstructive pulmonary disease; Non-invasive ventilation; Influencing factors

Online publication: November 28, 2024

1. Introduction

Chronic obstructive pulmonary disease (COPD) is characterized primarily by progressive and irreversible airflow limitation, posing a significant threat to the health of middle-aged and elderly individuals^[1]. During

acute exacerbations of COPD (AECOPD), airway narrowing, respiratory infections, and respiratory muscle fatigue can lead to type II respiratory failure, which, if inadequately controlled, may become life-threatening^[2]. Current clinical treatment prioritizes non-invasive ventilation (NIV) for its ease of operation, reduced trauma, and lower risk of complications, providing rapid relief from hypercapnia and hypoxemia while restoring respiratory function^[3]. Studies indicate that approximately 26%–74% of patients with acute exacerbation of COPD complicated by type II respiratory failure require intubation combined with mechanical ventilation to ensure adequate oxygen supply, improve gas exchange, and stabilize blood oxygen levels, thus reducing respiratory workload. However, in practical treatment settings, some patients continue to exhibit suboptimal outcomes and poor prognosis^[4]. A thorough investigation into potential risk factors contributing to NIV failure in AECOPD patients with type II respiratory failure, along with the implementation of targeted interventions, is crucial for improving patient prognosis. This study aims to analyze clinical data from AECOPD patients with type II respiratory failure admitted to Gaoyou People's Hospital between January 2020 and June 2023 to identify potential risk factors for NIV failure.

2. Materials and methods

2.1. General information

A total of 122 AECOPD patients with Type II respiratory failure admitted to Gaoyou People's Hospital between January 2020 and June 2023 were selected. All patients received immediate ECG monitoring and non-invasive ventilatory support upon admission, along with comprehensive treatments including anti-infective therapy, antispasmodics, bronchodilators, and expectorants. The cohort included 86 male and 36 female patients, aged between 55 and 95 years, with a mean age of 74.00 ± 7.89 years. All patients and their families were informed of the study and signed consent forms. This study was approved by the hospital's ethics committee.

Inclusion criteria were as follows: (1) patients met the criteria for AECOPD as defined by the Chinese Medical Association's Respiratory Disease Committee's "Guidelines for the Diagnosis and Treatment of Chronic Obstructive Pulmonary Disease" (2013 revised version); (2) history of a previous diagnosis of COPD; (3) confirmation of condition through pulmonary function testing, chest X-ray, and laboratory tests; (4) recent onset of symptoms such as shortness of breath, worsening cough, and production of thick, purulent sputum; (5) complete medical records; (6) age of 55 years or older.

Exclusion criteria included: (1) patients with oral or pharyngeal deformities or cervical spine injuries preventing intubation; (2) those with respiratory diseases other than AECOPD; (3) patients with severe infections such as sepsis; and (4) cases with incomplete medical record data, precluding detailed statistical analysis.

2.2. Methods

All patients underwent standard treatments, including non-invasive mechanical ventilation, anti-infective therapy, expectorants, cough suppressants, antispasmodics, and bronchodilators. Cardiac pacemakers were placed, and non-invasive ventilatory support was provided. A tracheal catheter was inserted in advance, enabling positive pressure mechanical ventilation. Basic patient information was collected, including gender, age, pH, arterial oxygen partial pressure (PaO_2), arterial carbon dioxide partial pressure (PaCO_2), neutrophil count (NEUT), C-reactive protein (CRP), procalcitonin (PCT), albumin (ALB), and tidal volume. The rate of

weaning failure was recorded, and these factors were analyzed for their impact on the weaning process.

2.3. Statistical analysis

Data analysis was performed using SPSS 23.0 statistical software. Measurement data with a normal distribution were expressed as mean \pm standard deviation (SD), with between-group comparisons performed using the *t*-test. Data not conforming to a normal distribution were expressed as a median and interquartile range, with between-group comparisons conducted using the Mann-Whitney test. Categorical data were presented as relative numbers, with comparisons made using the χ^2 test. Multivariate logistic regression analysis was used to identify factors influencing non-invasive ventilation failure. A significance level of $P < 0.05$ indicated statistical significance.

3. Results

3.1. Non-invasive ventilation failure in patients

Of the 122 AECOPD patients with Type II respiratory failure who received non-invasive ventilatory support, 30 experienced failure of non-invasive mechanical ventilation, accounting for 24.59%.

3.2. Univariate analysis of factors influencing non-invasive ventilation

There were statistically significant differences in CRP, pH, and PaCO₂ between patients with successful non-invasive ventilation and those with failed non-invasive ventilation ($P < 0.05$). However, no statistically significant differences were found in gender, age, PaO₂, NEUT, PCT, ALB, or tidal volume between the two groups ($P > 0.05$). See **Table 1**.

Table 1. Univariate analysis of factors influencing non-invasive ventilation [*n* (%)]

Factors		Ventilation failure group (<i>n</i> = 30)	Ventilation success group (<i>n</i> = 92)	<i>t</i> / <i>Z</i> / χ^2	<i>P</i>
Gender (cases)	Male	18 (60.00)	68 (73.91)	2.105	0.147
	Female	12 (40.00)	24 (26.09)		
Age (years)	< 65	4 (13.33)	9 (9.79)	0.300	0.584
	≥ 65	26 (86.67)	83 (90.22)		
pH		7.33 \pm 0.08	7.38 \pm 0.08	-3.105	0.002
PO ₂ (mmHg)		81.83 \pm 34.06	88.19 \pm 33.38	-0.89	0.375
PCO ₂ (mmHg)		82.50 \pm 20.09	66.14 \pm 15.34	4.634	0.000
NEUT ($\times 10^9/L$)		6.01 \pm 3.37	5.71 \pm 2.62	0.508	0.612
CRP (mg/L)		24.10 (4.3, 47.4)	6.48 (1.4, 23.7)	-2.008	0.045
PCT (ng/mL)		0.04 (0.0, 0.1)	0.04 (0.0, 0.1)	-0.175	0.861
ALB (g/L)		37.27 \pm 5.31	38.08 \pm 4.15	-0.84	0.403
Tidal volume (mL/kg)	6–8	16 (53.33)	42 (45.65)	0.535	0.464
	8–10	14 (46.67)	50 (54.35)		

3.3. Multivariate analysis of factors influencing non-invasive ventilation

Non-invasive ventilation failure was included as the dependent variable, and the factors with statistically significant differences in the univariate analysis were included as independent variables. See **Table 2** for variable assignments.

Table 2. Variable assignments

Factors	Assignment
pH	pH < 7.35 = 1; pH ≥ 7.35 = 0
PaCO ₂ (mmHg)	PaCO ₂ ≥ 70 = 1; PaCO ₂ < 70 = 0
CRP (mg/L)	CRP ≥ 7 = 1; CRP < 7 = 0

Based on logistic regression analysis, CRP, pH, and PaCO₂ were identified as independent risk factors for non-invasive ventilation failure ($P < 0.05$). See **Table 3**.

Table 3. Multivariate analysis factors influencing non-invasive ventilation failure

Factor	β	SE	Wald	P	OR	95% CI
pH	0.237	0.341	0.481	0.488	1.267	0.624–2.473
PaCO ₂ (mmHg)	0.290	0.186	2.430	0.119	1.337	0.928–1.926
CRP (mg/L)	0.443	0.205	4.669	0.031	1.557	1.042–2.327

4. Discussion

Chronic obstructive pulmonary disease is a serious public health concern that significantly reduces quality of life and increases mortality rates, imposing a considerable economic burden on individuals, families, and society. According to the 2018 China Pulmonary Health Study, the prevalence of COPD among adults aged 20 and over in China reached 8.6%, rising to 13.7% in those aged 40 and above. Characterized by persistent airflow limitation and associated lung symptoms, COPD involves pathological changes primarily affecting bronchial and alveolar function, often triggered by exposure to harmful particles or gases^[5]. Additionally, genetic susceptibility, immune dysregulation, and poor lung development contribute to COPD pathogenesis. Acute exacerbations of COPD represent severe episodes marked by respiratory distress, intense coughing, and excessive purulent sputum production, requiring adjustments in medication therapy^[6]. Non-invasive mechanical ventilation has become a widely adopted intervention for AECOPD with type II respiratory failure, aiming to alleviate respiratory acidosis, reduce PaCO₂ levels, breathing frequency, and perceived respiratory effort, thereby decreasing hospitalization duration, mortality risk, and the need for endotracheal intubation. NIV also helps mitigate airway damage, lowers the incidence of ventilator-associated pneumonia, and reduces sedative dependency, minimizing patient discomfort^[7].

While ventilation is essential in managing AECOPD with type II respiratory failure, the efficacy of NIV varies. In some cases, ventilation does not significantly improve the patient's condition post-intubation, leading to recurrence after extubation. Therefore, it is clinically important to investigate the factors contributing to NIV failure to enhance patient stability and improve weaning success rates.

This study found significant differences in CRP, pH, and PaCO₂ levels between patients who succeeded with NIV and those who failed ($P < 0.05$). Further analysis revealed that PaCO₂ and pH are indicative of lung ventilation capacity and hypoxia severity in AECOPD patients with respiratory failure. However, impaired baseline pulmonary ventilation in these patients can hinder responsiveness to NIV, affecting treatment outcomes. Elevated CRP levels directly reflect the severity of inflammation, necrosis, and both acute and chronic conditions, all of which influence the effectiveness of non-invasive mechanical ventilation.

5. Conclusion

In conclusion, CRP, pH, and PaCO₂ are independent risk factors for NIV failure. Identifying these risk factors promptly and implementing timely medical interventions can reduce the rate of NIV treatment failure.

Disclosure statement

The authors declare no conflict of interest.

References

- [1] Wei J, Zhong M, Li X, 2024, Effectiveness of High-Flow Nasal Oxygen Therapy in COPD Patients with Mild Type II Respiratory Failure. *Journal of Clinical Internal Medicine*, 41(7): 483–485.
- [2] Zhong N, Wang C, Yao W, et al., 2007, Prevalence of Chronic Obstructive Pulmonary Disease in China: A Large, Population-Based Survey. *Am J Respir Crit Care Med*, 176(8): 753–760. <https://doi.org/10.1164/rccm.200612-1749OC>. Erratum in *Am J Respir Crit Care Med*, 176(11): 1169.
- [3] Wang C, Xu J, Yang L, et al., 2018, Prevalence and Risk Factors of Chronic Obstructive Pulmonary Disease in China (the China Pulmonary Health [CPH] Study): A National Cross-Sectional Study. *Lancet*, 391(10131): 1706–1717. [https://doi.org/10.1016/S0140-6736\(18\)30841-9](https://doi.org/10.1016/S0140-6736(18)30841-9)
- [4] Wei N, Zhou B, Fu X, 2021, Analysis of Factors Related to Failure of Sequential Invasive-Non-Invasive Mechanical Ventilation in AECOPD with Respiratory Failure. *Hainan Medical Journal*, 32(4): 446–449.
- [5] Li J, 2020, Multivariate Analysis of Factors Leading to Weaning Failure in Elderly AECOPD Patients with Respiratory Failure on Mechanical Ventilation. *Chinese Journal of Clinical Physicians*, 48(1): 57–60.
- [6] Sun J, Cui Y, Zhang X, et al., 2024, Efficacy of Non-Invasive Positive Pressure Ventilation and High-Flow Nasal Oxygen Therapy in AECOPD Patients with Mild Respiratory Failure. *Practical Clinical Journal*, 21(1): 68–71.
- [7] Sun J, Liu Y, Li X, et al., 2022, Evaluation of the Effectiveness of Home Non-Invasive Ventilation in Stable COPD Patients with Type II Respiratory Failure. *Hebei Medical Journal*, 44(8): 1172–1175.

Publisher's note

Bio-Byword Scientific Publishing remains neutral with regard to jurisdictional claims in published maps and institutional affiliations.

A Case Report of Disseminated Nocardiosis

Rong Pang, Lingwei Wang*

Second Clinical Medical College of Jinan University, Guangzhou 510632, Guangdong Province, China

*Corresponding author: Lingwei Wang, limey@sina.com

Copyright: © 2024 Author(s). This is an open-access article distributed under the terms of the Creative Commons Attribution License (CC BY 4.0), permitting distribution and reproduction in any medium, provided the original work is cited.

Abstract: *Objective:* To summarize the clinical characteristics and treatment plan for a case of disseminated nocardiosis. *Methods:* The study summarized the clinical characteristics and treatment plan for a case of disseminated nocardiosis. *Results:* The primary symptoms of the patient included high fever and multiple enlarged lymph nodes. Chest computed tomography revealed a shadow of nodules in the upper lobe of the left lung, multiple nodules, and pleural effusion in both lungs. Additionally, bilateral blood cultures indicated the presence of *Nocardia terpenica*. The final diagnosis was disseminated *Nocardia sp.* infection. Upon admission, anti-infective treatment was initiated with sulfamethoxazole and linezolid. *Conclusion:* In patients with normal immune function, disseminated nocardiosis may present as high fever with lymph node enlargement, necessitating differentiation from lymphoma. This study reports on the diagnosis and treatment plan of a case of disseminated nocardiosis to enhance understanding and clinical management of this disease.

Keywords: *Nocardia terpenica*; Disseminated nocardiosis; Pulmonary infection; Septicemia; Case report

Online publication: November 26, 2024

1. Clinical data

A 50-year-old man was admitted to the hospital with complaints of general fatigue lasting over 10 days and a fever persisting for 4 days. He was admitted to the Respiratory Department on May 4, 2020. More than 10 days prior to admission, the patient experienced fatigue without any apparent cause. Four days before admission, he developed repeated high fevers, with the highest temperature reaching 39°C, but no cough, expectoration, chest tightness, shortness of breath, or other discomfort was reported. One day before admission, laboratory tests revealed a leukocyte count of $12.44 \times 10^9/L$, an absolute neutrophil count of $11.32 \times 10^9/L$, an absolute lymphocyte count of $0.40 \times 10^9/L$, a hypersensitive C-reactive protein level of 273.62 mg/L, and a procalcitonin level of 2.74 ng/mL. Chest computed tomography (CT) showed inflammation in both lungs. Left lung nodules were evaluated, and neoplastic lesions were investigated, along with a small amount of bilateral pleural effusion and incomplete expansion. Abdominal CT revealed bilateral renal exudation, effusion in the left colonic sulcus, and inflammatory changes near the left ureter (**Figure 1**). The patient denied any history of chronic disease. He worked as a farmer and had a 20-pack-year smoking history but no history of alcohol use.

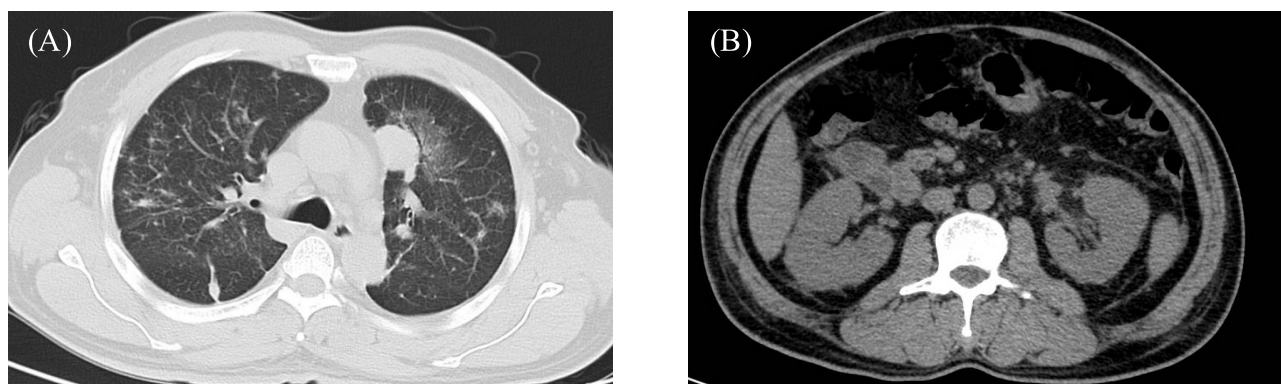


Figure 1. (A) Chest CT showing patchy blurred shadows and multiple small nodular shadows in both lungs. A nodule approximately 25 mm in diameter was observed near the mediastinum of the left upper lung without distinct spiculations. Small bilateral pleural effusions and adjacent lung parenchyma were noted. The trachea and main bronchial branches were patent, and no enlarged lymph nodes were found in the bilateral hilum or mediastinum. **(B)** Abdominal CT showing bilateral perirenal exudation, thickened fascia, slight effusion in the left paracolic groove, slight dilation of the left ureter's upper segment, peripheral exudation, and slight effusion in the pelvic cavity

Upon admission, physical examination showed a temperature of 38.7°C, a pulse rate of 96 beats per minute, a respiratory rate of 22 breaths per minute, and a blood pressure of 116/72 mmHg. The patient was alert and responsive. Moist rales were present in both lungs, scattered rash was observed across the body, and multiple cord-like swollen lymph nodes were palpable under the neck and in the armpits.

- (1) Admission diagnosis: Fever; suspected lung infection. Evaluation of lung nodule characteristics was pending.
- (2) Treatment: Upon admission, the patient's condition was monitored closely. Routine blood analysis indicated the following: white blood cell count, $10.65 \times 10^9/L$; neutrophil percentage, 89.90%; creatinine, 162 $\mu\text{mol/L}$; eGFR, 42.08 $\text{mL}/(\text{min} \cdot 1.73 \text{ m}^2)$; hypersensitivity C-reactive protein, 287.36 mg/L ; procalcitonin, 2.74 ng/mL ; interleukin 6, 156.1 pg/mL ; erythrocyte sedimentation rate, 80 mm/h ; complement C3, 0.46 g/L ; and complement C4, 0.06 g/L . Lymphocyte subset analysis revealed $\text{CD3}^+ \text{CD4}^+/\text{CD3}^+ \text{CD8}^+$: 17.70%; absolute $\text{CD3}^+ \text{CD8}^+$: 275.50 $\text{cells}/\mu\text{L}$; absolute $\text{CD3}^+ \text{CD4}^+$: 98.93 $\text{cells}/\mu\text{L}$; and absolute $\text{CD3}^- \text{CD19}^+$: 65.86 $\text{cells}/\mu\text{L}$. A syphilis test, including reagin titers, returned positive results: syphilis serum reagin titer, 1:256; specific syphilis antibodies, 21.41. Results for G test, GM test, respiratory virus panel, influenza virus antigen, mycoplasma pneumoniae IgM, TORCH, tuberculosis immune assay, enterovirus nucleic acid, and multiple tumor markers were within normal ranges. Spinal lymph node ultrasound detected involvement of the bilateral cervical, left supraclavicular, and bilateral axillary regions. Echocardiography showed slightly elevated pulmonary artery pressure (PASP = 36 mmHg). The patient's high fever persisted, and pleural fluid and urine cultures were negative, as were initial blood cultures. Bronchoscopic biopsy of the lung tissue revealed chronic inflammation, widening of the alveolar septa, fibrosis, and an increase in tissue cells within alveolar spaces. Immunohistochemistry was positive for TTF-1, CD68, and CK7, while special staining for acid-fast bacilli, PAS, and silver was negative (**Figure 2**). A lymphoma diagnosis was not excluded, given the patient's high fever and multiple swollen lymph nodes.

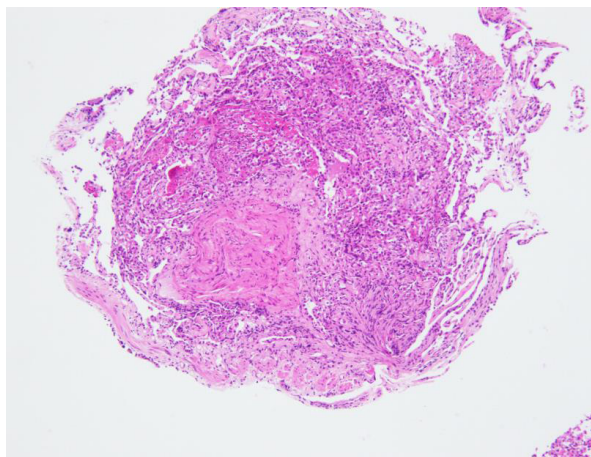


Figure 2. Left upper lung tissue biopsy revealed chronic inflammation in bronchial mucosa and lung tissue, widening of some alveolar septa, fibrosis, increased cellularity in alveolar spaces, and mild alveolar epithelial hyperplasia without signs of suppurative pathology

On May 11, PET-CT indicated high metabolic activity in multiple lymph nodes. Metabolic activity was elevated in soft tissue shadows in the left upper lobe and across both lungs. Increased spleen volume and metabolic activity, localized metabolic activity in the left kidney, and increased systemic bone marrow metabolism were noted (**Figure 3**). No abnormal phenotypic cells were found on bone marrow flow cytometry, and a bone marrow smear showed significant hyperplasia with diverse lymphocytes.

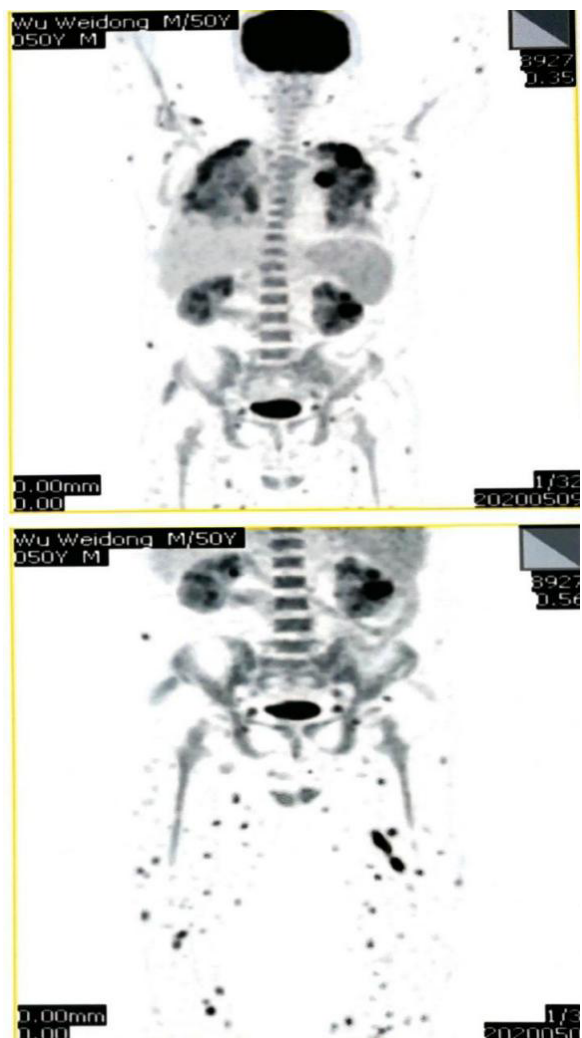


Figure 3. PET-CT findings: Elevated metabolic activity in multiple lymph nodes, soft tissue shadows in the left upper lobe, and multiple areas in both lungs. Diffuse metabolic activity was seen in the spleen, left kidney, muscle spaces, subcutaneous tissues, and bone marrow

Empirical treatment with moxifloxacin (400 mg daily) was started after admission, but the patient's fever persisted. On May 6, linezolid (600 mg every 12 hours) and oral valacyclovir (0.3 g twice daily) were added. Despite treatment, high fevers and multiple painless swollen lymph nodes persisted. Differential diagnoses included lymphoma, sarcoidosis, and carcinomatous lymphangitis, although sepsis and infective endocarditis could not be ruled out. Benzathine penicillin (2.4 million units, divided into two gluteal injections) was given for secondary syphilis on May 8. Body temperature normalized on May 9, and subsequent blood cultures were negative. By May 15, blood cultures grew *Nocardia* sp., confirming disseminated nocardiosis. Treatment included oral sulfamethoxazole (0.96 g four times daily, adjusted for renal function). Sputum Gram staining showed 90° branching, long filamentous Gram-positive bacteria (**Figure 4**).

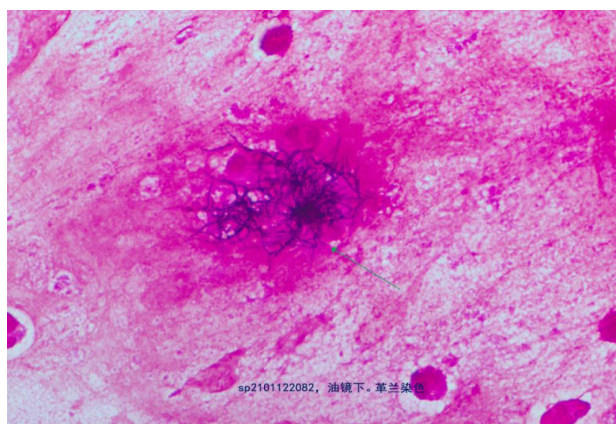


Figure 4. Gram staining (1,000×): Clusters of 90° branching, long filamentous Gram-positive bacteria

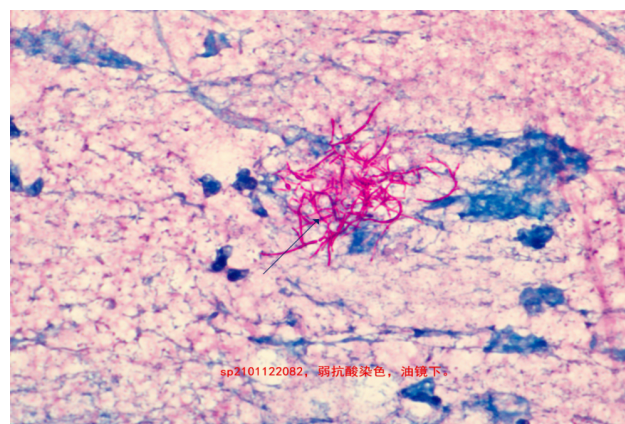


Figure 5. Weak acid-fast staining (1,000×) revealed clustered, positive mycobacteria

Weak acid-fast staining was positive, with a 1,000-fold microscopic aggregation and positive mycobacteria (**Figure 5**). 16S rRNA sequencing identified the bacteria as *Nocardia terpenica*. After a 5-day culture of transferred blood plates, the colonies appeared drier and milky white with wrinkled surfaces and emitted a soil odor (**Figure 6**). Bilateral blood cultures confirmed *Nocardia terpenica* (positive time: 71.7 hours left, 87.2 hours right) and were negative for mycobacteria.



Figure 6. After 5 days of culture on transferred blood plates, the colonies appeared drier, milky white, with wrinkled folds on the surface and an earthy odor

The broth microdilution method recommended by the Clinical and Laboratory Standards Institute was used. The Thermo Fly reagent results showed the following minimum inhibitory concentrations (MIC): compound sulfamethoxazole: 20 mg/mL; imipenem: ≤ 2 mg/mL; TCana: ≤ 1 mg/mL; linezolid: ≤ 1 mg/mL; moxifloxacin: 1 mg/mL; clarithromycin: ≤ 0.06 mg/mL; tobramycin: ≤ 1 mg/mL; ciprofloxacin: 2 mg/mL; doxycycline: 1 mg/mL; minocycline: 4 mg/mL; cefepime: 32 mg/mL; ceftriaxone: 64 mg/mL; and amoxicillin: > 64 mg/mL (**Table 1**). Sulfamethoxazole, linezolid, and moxifloxacin were sensitive with no adjustments needed. C-reactive protein levels decreased significantly; however, multiple lymph nodes remained enlarged. Consequently, a lymph node puncture biopsy was recommended to rule out lymphoma. However, due to the risk of infection spread, lymph node needle biopsy was temporarily deferred. The patient was discharged following stabilized infection control, with follow-up PET-CT and potential lymph node biopsy if necessary.

Table 1. Susceptibility testing using Thermo Fly reagent (sample no.: 2005051033)

Antibiotic	Result	Method	Drug sensitivity
Compound sulfamethoxazole	20	MIC	S
Imipenem	≤ 2	MIC	S
Butylamine kanamycin	≤ 1	MIC	S
Linezolid	≤ 1	MIC	S
Moxifloxacin	1	MIC	S
Clarithromycin	≤ 0.06	MIC	S
Nebcin	≤ 1	MIC	S
Ciprofloxacin	2	MIC	I
Doxycycline	1	MIC	I
Minocycline	4	MIC	I
Cefepime	32	MIC	R
Ceftriaxone	64	MIC	R
Amoxicillin	> 64	MIC	R

After discharge, moxifloxacin was replaced with oral moxifloxacin 0.4 g, sulfamethoxazole 0.96 g every 8 hours, and linezolid 600 mg every 12 hours. Side effects included nausea, vomiting, and swelling of the right foot. Linezolid was discontinued, moxifloxacin was stopped on June 19, and sulfamethoxazole was adjusted to 0.96 g twice daily as maintenance therapy. Three months post-discharge, chest CT showed absorption of the left upper lobe nodules and bilateral pleural effusion (**Figure 7**). A PET-CT review on June 8 showed no systemic signs of malignancy or lymphoma, with lymph node biopsy indicating reactive hyperplasia. In December 2024, a bone marrow examination revealed BCR/ABL P210 positivity, leading to a diagnosis of chronic myeloid leukemia in the chronic stage.

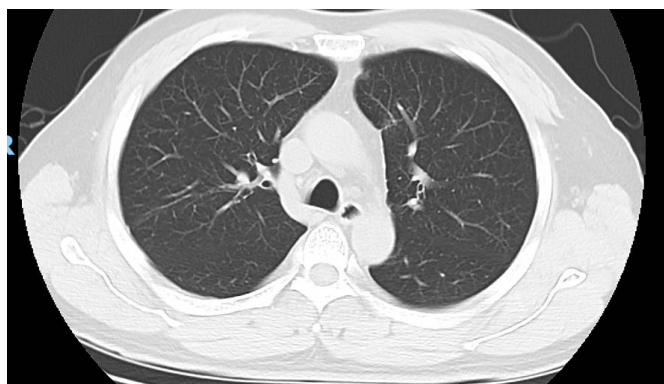


Figure 7. Chest CT re-examined on August 30, 2020, showed a tiny nodule approximately 1 mm in diameter in the anterior segment of the right upper lobe and lateral basal segment of the lower lobe, similar to previous imaging. A small fiber-like shadow was observed in the left upper lung, similar to earlier findings. A few cord-like structures were visible under the pleura of the left lower lobe. No pleural effusion was detected in either thoracic cavity. On the right side of the upper mediastinal trachea, a capsular bright shadow was noted, similar to previous imaging.

2. Discussion

Nocardia terpenica is an aerobic, filamentous, beaded, Gram-positive bacterium with weak acid-fast staining. This species is widely found in the environment, particularly in soil, organic matter, and water. Individuals may become infected through respiratory inhalation or contact with damaged skin, and infections are more common in those with immune deficiencies or immunosuppression. *N. farcinica* and *N. cyriacigeorgica* are the most common species in China ^[1,2]. First reported in Japan in 2007, *Nocardia terpenica* has been rarely isolated from clinical specimens ^[3] and accounts for only 2.2% of the known *Nocardia* species in China, primarily distributed along the southeast coast ^[2]. Disseminated nocardiosis is an infection involving non-contiguous organs, with *Nocardia* species being isolated and cultured from multiple sites or blood samples ^[4]. The case fatality rate for *Nocardia* infection is between 15.8% and 24.5% ^[5], with disseminated nocardiosis exhibiting a higher mortality rate and poor prognosis ^[6,7]. Although *Nocardia* infection can occur at any site, it most commonly affects the lungs, followed by the skin, brain, and other areas ^[4,8]. Chest CT is useful in diagnosing and assessing the severity of pulmonary nocardiosis, with possible CT findings including lobe consolidation, isolated or multiple nodules, peribronchial consolidation, and centrilobular nodules. The presence of cavities and pleural effusion is associated with disseminated pulmonary nocardiosis, and CT findings of multinodular consolidation are linked to a poor prognosis ^[5].

In this study, the patient was a middle-aged man with an acute presentation, high fever, multiple red rashes, and painless enlargement of multiple lymph nodes as the primary clinical symptoms. Chest imaging, including abdominal CT and PET-CT, indicated multiple nodules in both lungs, exudation from the upper ureter of both kidneys, and increased metabolism in the left lung nodules and lymph nodes. Bilateral blood cultures confirmed *Nocardia terpenica*, suggesting hematogenous dissemination and sepsis involving systemic organs. This study emphasizes that sulfamethoxazole remains the first-line treatment for *Nocardia* infections. This compound has long been the cornerstone of *Nocardia* treatment ^[1,2,8]. For cases resistant to trimethoprim-sulfamethoxazole or involving disseminated or severe infection, a combination of sulfamethoxazole with amikacin, imipenem, or a third-generation cephalosporin is recommended ^[9,10]. Immunocompetent patients with

pulmonary or non-central nocardiosis are advised to undergo treatment for 6 to 12 months ^[11]. In this case, the patient had disseminated *Nocardia* infection and was empirically treated with sulfamethoxazole, linezolid, and moxifloxacin. The patient was discharged after his temperature normalized and continued on sequential oral treatment with sulfamethoxazole, linezolid, and moxifloxacin. Follow-up chest CT revealed significant lesion absorption, leading to the discontinuation of moxifloxacin and linezolid while sulfamethoxazole was maintained as a maintenance therapy. The patient also presented with high fever and systemic lymphadenopathy, raising concerns for lymphoma. A post-discharge PET-CT showed no signs of lymphoma, and lymph node biopsy indicated reactive hyperplasia, suggesting that lymphadenopathy was related to disseminated nocardiosis. Clinical manifestations of disseminated nocardiosis are non-specific and may include cough, expectoration, fever, and other symptoms, complicating differentiation from other bacterial infections or tumors. Due to the low detection rate, cases are often misdiagnosed, missed, or diagnosed late, leading to disease progression. Clinicians should improve awareness of this condition and ensure thorough re-examination in suspected cases, with close collaboration with microbiology labs. Additionally, extending culture time and increasing detection efforts can help facilitate earlier diagnosis and treatment.

Disclosure statement

The authors declare no conflict of interest.

References

- [1] Han Y, Cheng M, Li Z, et al., 2024, Clinical Characteristics and Drug Resistance of *Nocardia* in Henan, China, 2017–2023. *Ann Clin Microbiol Antimicrob*, 23(1): 23. <https://doi.org/10.1186/s12941-024-00677-4>
- [2] Wang C, Sun Q, Yan J, et al., 2023, The Species Distribution and Antimicrobial Resistance Profiles of *Nocardia* Species in China: A Systematic Review and Meta-Analysis. *PLoS Negl Trop Dis*, 17(7): e0011432. <https://doi.org/10.1371/journal.pntd.0011432>
- [3] Hoshino Y, Watanabe K, Iida S, et al., 2007, *Nocardia terpenica* sp. nov., Isolated from Japanese Patients with Nocardiosis. *International Journal of Systematic and Evolutionary Microbiology*, 57(7): 1456–1460. <https://doi.org/10.1099/ijs.0.64695-0>
- [4] Gupta S, Grant LM, Powers HR, et al., 2023, Invasive *Nocardia* Infections across Distinct Geographic Regions, United States. *Emerg Infect Dis*, 29(12): 2417–2425. <https://doi.org/10.3201/eid2912.230673>
- [5] Lee HN, Do KH, Kim EY, et al., 2024, Comparative Analysis of CT Findings and Clinical Outcomes in Adult Patients With Disseminated and Localized Pulmonary Nocardiosis. *J Korean Med Sci*, 39(11): e107. <https://doi.org/10.3346/jkms.2024.39.e107>
- [6] Soueges S, Bouiller K, Botelho-Nevers E, et al., 2022, Prognosis and Factors Associated with Disseminated Nocardiosis: A Ten-Year Multicenter Study. *J Infect*, 85(2): 130–136. <https://doi.org/10.1016/j.jinf.2022.05.029>
- [7] Presant CA, Wiernik PH, Serpick AA, 1973, Factors Affecting Survival in Nocardiosis. *Am Rev Respir Dis*, 108(6): 1444–1448. <https://doi.org/10.1164/arrd.1973.108.6.1444>
- [8] Liu P, Wang Z, Jian Z, et al., 2023, The Clinical Characteristic and Management of Patients with Nocardiosis in a Tertiary Hospital in China. *J Microbiol Biotechnol*, 33(5): 574–581. <https://doi.org/10.4014/jmb.2209.09034>
- [9] Saubolle MA, Sussland D, 2003, Nocardiosis: Review of Clinical and Laboratory Experience. *J Clin Microbiol*,

41(10): 4497–4501. <https://doi.org/10.1128/JCM.41.10.4497-4501.2003>

- [10] Margalit I, Lebeaux D, Tishler O, et al., 2021, How Do I Manage Nocardiosis? *Clin Microbiol Infect*, 27(4): 550–558. <https://doi.org/10.1016/j.cmi.2020.12.019>
- [11] Balachandar A, Zhabokritsky A, Matukas LM, 2020, Disseminated Nocardiosis with Multisite Involvement in An Immunocompetent Patient. *CMAJ*, 192(33): E956–E959. <https://doi.org/10.1503/cmaj.200153>

Publisher's note

Bio-Byword Scientific Publishing remains neutral with regard to jurisdictional claims in published maps and institutional affiliations.

The Impact of Bundled Nursing Interventions Based on Empowerment Theory on Patients with Indwelling Urinary Catheters

Yongna Qu*

Suzhou BOE Hospital, Suzhou 215200, Jiangsu Province, China

*Corresponding author: Yongna Qu, Qny20240501@qq.com

Copyright: © 2024 Author(s). This is an open-access article distributed under the terms of the Creative Commons Attribution License (CC BY 4.0), permitting distribution and reproduction in any medium, provided the original work is cited.

Abstract: *Objective:* To explore the value of bundled nursing interventions based on empowerment theory in the care of patients with indwelling urinary catheters. *Methods:* Forty-two patients with indwelling urinary catheters, admitted from June 2022 to June 2023, were sampled and randomly divided using a random number table. Group A received bundled nursing care based on empowerment theory, while Group B received standard care. The differences in catheterization duration, unplanned extubation rate, emotional scores, quality of life scores, and adverse events were compared. *Results:* Group A had a shorter catheterization duration and a lower rate of unplanned extubation than Group B, with $P < 0.05$. Anxiety (SAS) and depression (SDS) scores were lower in Group A than in Group B, with $P < 0.05$, and the quality of life (SF-36) scores were higher in Group A than in Group B, with $P < 0.05$. The adverse event rate for Group A was also lower than that for Group B, with $P < 0.05$. *Conclusion:* Patients with indwelling urinary catheters who received bundled nursing care based on empowerment theory experienced improved emotional stability, optimized quality of life, fewer unplanned extubation events, and the intervention was highly effective and feasible.

Keywords: Indwelling urinary catheter patients; Bundled nursing; Empowerment theory; Impact

Online publication: November 28, 2024

1. Introduction

Urinary tract infections are common complications among hospitalized patients, potentially prolonging recovery times, increasing medical costs, and even impacting treatment effectiveness. Additionally, prolonged catheterization can heighten physical and mental stress, adversely affecting patients' adherence to treatment. Therefore, it is necessary to implement nursing interventions for patients with indwelling catheters to reduce related adverse events. Conventional nursing, which primarily relies on passive service, cannot adequately meet the needs of modern patients with indwelling catheters^[1]. Bundled nursing integrates contemporary nursing practices with evidence-based medicine, combining a series of nursing measures to provide scientifically sound

and targeted services for indwelling catheter care. Nursing adjustments based on empowerment theory can improve the operability of bundled care and reduce clinical nursing adverse events ^[2]. This study examines the value of applying bundled nursing interventions based on empowerment theory in 42 patients with indwelling urinary catheters treated from June 2022 to June 2023.

2. Materials and methods

2.1. General information

A total of 42 patients with indwelling urinary catheters, admitted from June 2022 to June 2023, were sampled and randomly divided using a random number table. Group A consisted of 12 males and 9 females, aged 35 to 77 years, with an average age of 54.19 ± 2.44 years. Group B included 13 males and 8 females, aged 34 to 78 years, with an average age of 54.21 ± 2.46 years. There was no statistically significant difference between Groups A and B in patient demographics ($P > 0.05$).

Inclusion criteria: (1) Patients indicated for indwelling urinary catheterization; (2) Informed consent provided; (3) Stable vital signs including heart rate, respiratory rate, pulse, and temperature.

Exclusion criteria: (1) Critically ill patients with a life expectancy of less than three months; (2) Patients with psychiatric disorders; (3) Patients with poor reading and comprehension abilities.

2.2. Methods

2.2.1. Group A: bundled nursing based on empowerment theory

- (1) Establishing a bundled care team: The head nurse acted as team leader, with experienced nurses in catheter care as team members. Weekly training sessions were conducted, covering nursing theory and practical skills for various diseases. The team leader reviewed unique nursing cases, facilitating group discussions and analysis of nursing strategies. Based on the actual situation of the department, assessment strategies were improved, with rewards for high-quality service and penalties for poor service quality.
- (2) Cognitive intervention: A comprehensive educational manual was prepared, detailing knowledge about disease triggers, symptoms, and precautions, and highlighting cases of successful recovery with long-term indwelling catheters to boost patient confidence. Hospitalized patients with catheters were invited to join a WeChat group where the responsible nurse shared catheter care knowledge through text, video, and images for easy reference. Patients' families were encouraged to attend expert lectures to improve their understanding of catheter care.
- (3) Emotional intervention: Indwelling urinary catheters can reduce quality of life, increase anxiety and depression, and sometimes cause a loss of hope. Nurses were trained to identify and address the triggers of emotional fluctuations and to provide timely guidance to alleviate patients' negative emotions. Nurses also encouraged patients to express their thoughts and answered their questions patiently to boost their recovery confidence.
- (4) Dietary intervention: Different patients have different primary diseases, so dietary adjustments were made according to their physiological state to ensure a balanced intake of nutrients. Patients were advised to avoid cold and fried foods.
- (5) Exercise intervention: Exercise plans were tailored according to each patient's recovery status. If a

patient could not get out of bed, family members were instructed to massage the patient's limbs and help them turn over. For patients able to move independently, they were encouraged to engage in regular physical activity.

(6) Catheter care interventions:

- (a) Pre-catheterization: Patient history was reviewed, including any previous urinary tract injury or infection history. Patients were guided to complete laboratory tests to assess the risk factors for urinary tract infections, and evaluations were conducted on their mobility and emotional stability, as well as the risk of unplanned extubation. Specific care measures were developed for patients with high-risk factors.
- (b) During catheterization: The procedure was conducted under sterile protocol, with precautions taken to prevent contamination of the urethral meatus. The urethral and surrounding skin were disinfected with 0.5% povidone-iodine; the catheterization depth was 4.6 cm for female patients and 20–22 cm for male patients. Nurses were instructed to operate gently to avoid damaging the urethral mucosa. Once catheterized, 10–15 mL of normal saline was slowly injected into the catheter balloon. If contamination occurred during the procedure, the catheter was immediately replaced to prevent reuse of contaminated catheters.
- (c) Post-catheterization: The frequency of rounds was increased, the catheter was secured to prevent kinking or bending, and the urine bag was placed above the patient's bladder to prevent backflow and reverse infection. The drainage bag's integrity and seal were monitored; the bag was clamped during patient activity to prevent backflow. Urine samples were collected for microbial pathogenic examination, and abnormalities were addressed immediately. The urethral meatus and adjacent skin were washed with 0.5% povidone-iodine to maintain cleanliness. For patients with fecal incontinence, additional local disinfection was conducted. Catheters were removed when removal criteria were met.

2.2.2. Group B: standard care

Hand hygiene was maintained according to aseptic principles, and the area was cleansed and disinfected before slowly inserting the catheter. After catheter insertion, patients were instructed to use warm water to clean the perineum to keep the area dry and clean.

2.3. Statistical analysis

Data were processed using SPSS 21.0. Count data were recorded as percentages and analyzed using the χ^2 test, while measurement data were recorded as mean \pm standard deviation (SD) and analyzed with the *t*-test. Statistical significance was set at $P < 0.05$.

3. Results

3.1. Urinary catheter retention time and unplanned extubation rates

The urinary catheter retention time in Group A was shorter than that in Group B, and the unplanned extubation rate in Group A was lower than in Group B ($P < 0.05$), as shown in **Table 1**.

Table 1. Analysis of urinary catheter retention time and unplanned extubation rate

Group	Catheter retention time (days)	Unplanned extubation rate [n (%)]
Group A (n = 21)	4.01 ± 1.06	0 (0.00)
Group B (n = 21)	6.58 ± 1.42	4 (19.05)
χ^2 / t	6.6463	4.4211
<i>P</i>	0.0000	0.0355

3.2. Emotional scores

After the nursing intervention, patients in Group A had lower Self-Rating Anxiety Scale (SAS) and Self-Rating Depression Scale (SDS) scores than those in Group B ($P < 0.05$). There was no significant difference in SAS and SDS scores between the two groups before nursing intervention ($P > 0.05$), as shown in **Table 2**.

Table 2. Comparison of emotional scores in patients with indwelling catheters before and after intervention (mean ± SD, points)

Group	SAS		SDS	
	Before	After	Before	After
Group A (n = 21)	54.19 ± 2.33	36.15 ± 1.06	55.26 ± 2.87	35.44 ± 1.55
Group B (n = 21)	54.21 ± 2.36	43.44 ± 1.42	55.29 ± 2.89	42.19 ± 1.48
<i>t</i>	0.0276	18.8526	0.0338	16.5037
<i>P</i>	0.9781	0.0000	0.9732	0.0000

3.3. Quality-of-life scores

After the nursing intervention, the SF-36 scores of patients in Group A were higher than those in Group B ($P < 0.05$). Before the nursing intervention, there was no difference in SF-36 scores between the two groups ($P > 0.05$), as shown in **Table 3**.

Table 3. Comparison of quality-of-life scores in patients with indwelling catheters before and after intervention (mean ± SD, points)

Group	Physical health		Mental health		Physical function		Mental function	
	Before	After	Before	After	Before	After	Before	After
Group A (n = 21)	64.19 ± 2.41	84.36 ± 3.68	65.18 ± 2.37	84.47 ± 3.72	64.74 ± 2.36	85.49 ± 3.68	65.72 ± 2.37	86.14 ± 3.71
Group B (n = 21)	64.22 ± 2.38	75.11 ± 3.11	65.21 ± 2.39	75.36 ± 3.06	64.72 ± 2.39	76.15 ± 3.11	65.69 ± 2.39	75.44 ± 3.06
<i>t</i>	0.0406	8.7978	0.0408	8.669	0.0273	8.8834	0.0408	10.1959
<i>P</i>	0.9678	0.0000	0.9676	0.000	0.9784	0.0000	0.9676	0.0000

3.4. Adverse events

The adverse event rate in Group A was lower than that in Group B ($P < 0.05$), as shown in **Table 4**.

Table 4. Comparison of adverse events in patients with indwelling catheters [*n* (%)]

Group	Catheter deformation	Catheter blockage	Leakage	Incidence rate
Group A (<i>n</i> = 21)	0 (0.00)	0 (0.00)	1 (4.76)	1 (4.76)
Group B (<i>n</i> = 21)	2 (9.52)	1 (4.76)	3 (14.29)	6 (28.57)
χ^2				5.2323
<i>P</i>				< 0.05

4. Discussion

Some hospitalized patients, due to the impact of their illness, are unable to urinate normally and require an indwelling catheter to assist with urination. However, long-term catheterization carries a risk of urinary tract infection, which can exacerbate patient discomfort and may even affect the treatment outcomes of the primary disease, prolonging hospital stays^[3]. Additionally, older patients with indwelling catheters are prone to incidents such as leakage and unplanned catheter removal due to various adverse effects. Therefore, it is essential to emphasize nursing interventions for patients with indwelling catheters to reduce physiological and psychological stress responses, improve patient comfort, and promote disease recovery^[4]. Conventional care practices primarily focus on sterile techniques and lack comprehensive and standardized care measures tailored to meet patients' actual needs, which can lead to a high incidence of catheter-related adverse events and insufficient overall nursing quality^[5]. The bundled care model, as a modern nursing strategy, adjusts the care plan based on specific patient issues and consists of a series of evidence-based measures that meet clinical nursing requirements and can improve patient prognosis. In this study, the bundled care approach was integrated with an empowerment education concept to provide multi-dimensional services covering cognition, emotion, diet, exercise, and catheter care, demonstrating comprehensive and scientific characteristics that can enhance nursing skills and improve care quality^[6,7].

Data analysis from this study shows that Group A had a shorter catheter retention time and a lower rate of unplanned extubations compared to Group B ($P < 0.05$). This can be attributed to the empowerment-based bundled care model, where a specialized care team led by a head nurse conducted regular training and assessments, enhancing the overall service quality of the nursing department. Regular case discussions and analysis of intervention strategies for unexpected incidents reduced the rate of unplanned extubations and shortened catheter retention time^[8,9]. Another set of data indicated that Group A had lower SAS and SDS scores and higher SF-36 scores than Group B ($P < 0.05$). This can be explained by the model's emphasis on patient education, delivered through educational booklets, WeChat support groups for catheterized patients, and expert-led lectures, which enhanced patients' understanding and confidence in recovery. The model also delved into the causes of patients' emotional fluctuations, addressed concerns about catheterization, alleviated anxiety, guided patients on healthy diets and scientific exercise, and provided nutritional support, thereby improving patients' physical condition and quality of life^[10].

Lastly, data showed that Group A had a lower rate of catheter-related adverse events than Group B ($P < 0.05$). The empowerment-based bundled care model emphasizes catheter care, with a thorough assessment of risk factors for different patients before catheterization and tailored adjustments to care strategies, which can meet the specific nursing needs of catheterized patients. Strict aseptic procedures during catheter insertion,

proactive prevention of contamination, and reverse infection events ensure patient safety. Post-catheterization, attention to catheter fixation, and drainage bag integrity can reduce adverse events such as leakage ^[3]. For patients with fecal incontinence, appropriate disinfection is performed, and for those meeting removal criteria, the catheter is removed to further reduce infection incidents, thus enhancing patient comfort.

5. Conclusion

In conclusion, the application of empowerment-based bundled care for patients with indwelling catheters can reduce unplanned extubation rates, shorten catheter retention time, stabilize patients' emotions, improve quality of life, and reduce catheter-related adverse events, demonstrating value for broader implementation.

Disclosure statement

The author declares no conflict of interest.

References

- [1] Fang T, 2023, Analysis of the Effect of Bundled Care Interventions on Urinary Tract Infections Related to Indwelling Catheters in Elderly Patients. *Forum of Primary Care Medicine*, 27(12): 61–63.
- [2] Zhang H, Xue D, Du J, et al., 2023, Application of Bundled Care Guided by Health Empowerment Theory in Tumor Patients with PICC Lines. *Nursing Practice and Research*, 20(24): 3761–3767.
- [3] Dai W, 2022, Impact of Bundled Care Intervention on Urinary Tract Infections and Adverse Events in Bedridden Patients with Indwelling Catheters after Cerebral Infarction. *Guide of China Medicine*, 20(7): 168–170.
- [4] Qian X, 2022, Study on the Impact of Bundled Care on Urinary Tract Infections in Cerebral Infarction Patients with Indwelling Catheters. *Chinese Health Care*, 40(10): 125–127.
- [5] Xie Q, Liu C, 2022, The Effect of Bundled Care on Postoperative Urinary Tract Infections and Catheter Retention Time in Urology Patients. *Chinese Scientific and Technological Journals Database (Full Version) – Medicine and Health*, 2022(11): 120–122.
- [6] Shi J, 2023, The Impact of Bundled Care on Quality of Life in Cancer Patients with Indwelling Upper Arm Infusion Ports. *Hebei Medicine*, 45(7): 1118–1120.
- [7] Luo L, 2023, Observation of the Effectiveness of Bundled Care in Long-term Hospitalized Elderly Patients with Indwelling Catheters. *Guide of China Medicine*, 21(30): 186–188 + F0003.
- [8] Yang C, 2023, The Impact of Bundled Care Interventions on PICC Line Blockages in Stroke Patients. *Research on Women's Health in China and Abroad*, 2023(2): 175–177.
- [9] Shu R, 2023, Impact of Bundled Care on Nursing Quality and Infection Prevention in Hepatobiliary Surgery Patients with Indwelling Central Venous Catheters. *Chinese Scientific and Technological Journals Database (Citation Version) – Medicine and Health*, 2023(3): 123–126.
- [10] Zhuang W, Lin R, Chen L, et al., 2022, Application of Comprehensive Bundled Care in Stroke Patients with Indwelling Catheters. *Guide of China Medicine*, 20(35): 162–164.

Publisher's note

Bio-Byword Scientific Publishing remains neutral with regard to jurisdictional claims in published maps and institutional affiliations.

Observation on the Effectiveness of Yinzhihuang Granules in the Treatment of Neonatal Jaundice

Xingwen Zhou, Boxia Li, Lin Zhu, Jianping Zhang, Wenyuan Cheng, Yuhui Wei*

Department of Pharmacy, First Hospital of Lanzhou University, Lanzhou 730000, Gansu Province, China

*Corresponding author: Yuhui Wei, zxwen1012@sina.com

Copyright: © 2024 Author(s). This is an open-access article distributed under the terms of the Creative Commons Attribution License (CC BY 4.0), permitting distribution and reproduction in any medium, provided the original work is cited.

Abstract: *Objective:* To analyze the therapeutic efficacy of Yinzhihuang granules in treating neonatal jaundice. *Methods:* A total of 62 neonates with jaundice, admitted from September 2021 to September 2023, were randomly divided into two groups. The observation group received Yinzhihuang granules, while the control group received conventional blue light therapy. The overall efficacy rate and other indicators were compared. *Results:* The observation group showed a higher overall efficacy rate and superior clinical indicators compared to the control group ($P < 0.05$). Before treatment, there was no significant difference between the two groups in bilirubin, liver function, or immune function indicators ($P > 0.05$). After one week of treatment, the observation group had lower bilirubin and liver function indicators and higher immune function indicators than the control group ($P < 0.05$). *Conclusion:* Yinzhihuang granules can improve the efficacy of neonatal jaundice treatment, accelerate recovery, reduce bilirubin levels, protect liver function, and enhance immune function in neonates.

Keywords: Yinzhihuang granules; Neonatal jaundice; Bilirubin indicators; Immune function indicators

Online publication: November 28, 2024

1. Introduction

Neonatal jaundice is a skin-yellowing disorder caused by bilirubin metabolism dysfunction, with blue light therapy being a common treatment that can accelerate jaundice resolution^[1]. Traditional Chinese Medicine (TCM) attributes the etiology of this condition to the invasion of cold, damp, and pathogenic toxins, requiring therapies such as dampness-clearing, jaundice-resolving, and heat-clearing detoxification. Yinzhihuang granules are a commonly used TCM formula for this condition, facilitating bilirubin absorption and shortening the course of the illness in neonates. Based on this premise, the present study selected 62 neonates with jaundice to evaluate the therapeutic effects of Yinzhihuang granules.

2. Materials and methods

2.1. General information

From September 2021 to September 2023, 62 neonates with jaundice were admitted and randomly divided into two groups. The observation group included 31 cases, with 18 males and 13 females; age ranged from 8 to 25 days, with a mean of (12.85 ± 2.42) days; weight ranged from 2.72 to 3.94 kg, with a mean of (3.25 ± 0.43) kg. The control group included 31 cases, with 19 males and 12 females; age ranged from 7 to 24 days, with a mean of (12.93 ± 2.58) days; weight ranged from 2.70 to 3.95 kg, with a mean of (3.27 ± 0.51) kg. Comparison of data between groups showed $P > 0.05$.

2.2. Methods

Both groups received basic therapy: nutritional support, appropriate warming, and oral administration of a bifidobacterium triple live bacterial powder. This was dosed at 0.5 g per time (half a packet), and taken twice daily for 7 days.

The observation group was treated with Yinzhihuang granules, taken at 1.5 g per dose, three times a day for 7 days. The control group received blue light phototherapy using a double-sided blue light box. Each exposure session lasted 6 to 8 hours, with a 4-hour break in between, continuing for 7 days.

2.3. Observation indicators

- (1) Clinical indicators: Observed indicators included jaundice resolution time, daily stool frequency, meconium clearance time, and hospital stay duration.
- (2) Bilirubin and liver function indicators: Fasting venous blood samples were collected before treatment and after one week of treatment. These samples were centrifuged at 3000 r/min for 30 minutes, and total bilirubin (TBIL), indirect bilirubin (IBIL), and direct bilirubin (DBIL) were measured using enzyme-linked immunosorbent assay (ELISA). Alanine transaminase (ALT) and aspartate transaminase (AST) were also measured as liver function indicators.
- (3) Immune function indicators: Venous blood samples were centrifuged, and bilirubin measurement was conducted using a bilirubinometer to determine $CD4^+$, $CD8^+$, and $CD4^+/CD8^+$ ratios.

2.4. Efficacy evaluation criteria

- (1) Significant efficacy: Bilirubin levels returned to normal, and skin yellowing resolved by more than 70%.
- (2) Initial efficacy: Bilirubin levels decreased, and skin yellowing resolved by 40% to 70%.
- (3) No efficacy: Bilirubin levels remained unchanged, and skin yellowing did not reach a 40% reduction.

2.5. Statistical analysis

Data were processed using SPSS 21.0 software. Measurement data were analyzed using *t*-tests and expressed as mean \pm standard deviation (SD), and count data were analyzed using χ^2 tests and expressed as [*n* (%)]. A *P*-value of less than 0.05 was considered statistically significant.

3. Results

3.1. Comparison of overall efficacy between groups

Table 1 shows that the overall efficacy rate of the observation group was higher than that of the control group ($P < 0.05$).

Table 1. Comparison of overall efficacy between groups [n (%)]

Group	n	Significant efficacy	Initial efficacy	No efficacy	Total effective rate
Observation group	31	20 (64.52)	10 (32.26)	1 (3.23)	96.77 (30/31)
Control group	31	16 (51.61)	8 (25.81)	7 (22.58)	77.42 (24/31)
χ^2	-	-	-	-	5.167
P	-	-	-	-	0.023

3.2. Comparison of clinical indicators between groups

Table 2 shows that the clinical indicators in the observation group were superior to those in the control group ($P < 0.05$).

Table 2. Comparison of clinical indicators between groups (mean \pm SD)

Group	n	Jaundice resolution time (d)	Daily stool frequency (times)	Meconium clearance time (d)	Hospital stay (d)
Observation group	31	6.24 \pm 1.53	5.39 \pm 0.87	1.86 \pm 0.36	6.95 \pm 1.80
Control group	31	9.37 \pm 1.78	4.40 \pm 0.76	2.77 \pm 0.42	10.79 \pm 1.93
t	-	7.425	4.772	9.159	8.101
P	-	0.000	0.000	0.000	0.000

3.3. Comparison of bilirubin and liver function indicators between groups

Before treatment, there was no difference in bilirubin indicators between the two groups ($P > 0.05$). After one week of treatment, bilirubin and liver function indicators in the observation group were lower than those in the control group ($P < 0.05$), see **Tables 3** and **4**.

Table 3. Comparison of bilirubin indicators between groups before and after treatment (mean \pm SD, $\mu\text{mol/L}$)

Group	n	TBIL		IBIL		DBIL	
		Before	After	Before	After	Before	After
Observation group	31	324.95 \pm 26.71	114.96 \pm 15.20	307.53 \pm 21.73	110.83 \pm 8.19	20.26 \pm 2.78	7.88 \pm 1.50
Control group	31	322.10 \pm 27.53	139.62 \pm 17.51	308.02 \pm 20.38	118.35 \pm 9.80	20.38 \pm 2.91	9.46 \pm 1.64
t	-	0.414	5.921	0.092	3.278	0.166	3.958
P	-	0.681	0.000	0.927	0.002	0.869	0.000

Table 4. Comparison of liver function indicators between groups before and after treatment (mean \pm SD, U/L)

Group	n	ALT		AST	
		Before	After	Before	After
Observation group	31	64.01 \pm 6.81	33.52 \pm 3.15	62.88 \pm 7.19	31.06 \pm 4.20
Control group	31	64.05 \pm 6.76	39.06 \pm 3.50	62.34 \pm 7.30	36.72 \pm 4.75
<i>t</i>	-	0.023	6.551	0.293	4.970
<i>P</i>	-	0.982	0.000	0.770	0.000

3.4. Comparison of immune function indicators between groups

Before treatment, there was no difference in immune function indicators between the two groups ($P > 0.05$). After one week of treatment, immune function indicators in the observation group were superior to those in the control group ($P < 0.05$), as shown in **Table 5**.

Table 5. Comparison of immune function indicators between groups (mean \pm SD, %)

Group	n	CD4 ⁺		CD8 ⁺		CD4 ⁺ /CD8 ⁺	
		Before	After	Before	After	Before	After
Observation group	31	38.15 \pm 4.36	46.55 \pm 6.13	21.58 \pm 2.79	23.68 \pm 1.62	1.74 \pm 0.60	2.19 \pm 0.43
Control group	31	38.19 \pm 4.21	41.21 \pm 6.05	22.04 \pm 2.91	22.17 \pm 1.56	1.77 \pm 0.59	1.90 \pm 0.35
<i>t</i>	-	0.037	3.452	0.635	3.738	0.198	2.912
<i>P</i>	-	0.971	0.001	0.528	0.000	0.843	0.005

4. Discussion

The etiology of neonatal jaundice is relatively complex. Possible causes include the persistent effects of bacterial toxins on red blood cells, leading to abnormal bilirubin excretion; low levels of bilirubin absorption-inhibiting enzymes in breast milk, which elevate blood bilirubin levels; and neonatal acidosis [2]. The standard treatment is phototherapy, which accelerates the breakdown of bilirubin in the skin, promoting its transformation into water-soluble isomers that are excreted via urine and bile. While phototherapy, a physical treatment, alleviates jaundice symptoms, it does not address the underlying cause, which limits its therapeutic effectiveness [3].

Traditional Chinese Medicine (TCM) views neonatal jaundice as a manifestation of “damp-heat fetal toxin,” where excessive damp-heat obstructs bile flow, leading to symptoms like jaundiced skin. The therapeutic principles include reducing jaundice, clearing heat and detoxifying, and promoting diuresis, for which Yinzhihuang granules are a suitable choice [4]. This herbal medicine, formulated entirely from traditional herbs, contains *Artemisia capillaris*, which helps reduce jaundice, promotes bile secretion, and clears heat and dampness; *Gardenia jasminoides*, known for its effects in clearing heat, cooling blood, promoting bile secretion, and protecting the liver; *Scutellaria baicalensis*, which has antipyretic, choleric, astringent, and heat-clearing properties; and *Lonicera japonica*, known for its anti-inflammatory, detoxifying, and heat-clearing effects [5].

The results showed that the overall efficacy rate of the observation group was higher than that of the

control group, and its clinical indicators were also superior. After one week of treatment, bilirubin and liver function indicators were lower, and immune function indicators were higher in the observation group compared to the control group ($P < 0.05$). These findings indicate that Yinzhihuang granules can significantly alleviate neonatal jaundice. *Artemisia capillaris*, which is rich in active ingredients like scoparone, protects liver and bile function, accelerates bile secretion, and promotes the excretion of bilirubin and bile acids. This helps prevent hepatic cell necrosis or degeneration, improving liver and bile function indicators ^[6]. *Gardenia jasminoides* contain gardenoside B and A, which enhance the liver's ability to uptake bilirubin and expedite its excretion. Additionally, *Gardenia* can boost the activity of hepatic glucuronyl transferase, significantly improving bilirubin excretion capacity and reducing bilirubin levels ^[7]. *Scutellaria baicalensis*, containing baicalin, has strong diuretic effects that facilitate the excretion of bilirubin via urine, thereby lowering its concentration in the body. *Lonicera japonica* contains chlorogenic acid, which inhibits the release of inflammatory mediators and prevents peroxidation of lipid components in cell membranes, thereby exerting hepatoprotective and choleric effects ^[8]. Combined with phototherapy, this regimen can regulate neonatal immune function, improve intestinal peristalsis, and reduce inflammatory responses, leading to lower bilirubin and liver function indicators and higher immune function indicators in neonates ^[9,10].

5. Conclusion

In conclusion, Yinzhihuang granules improve the effectiveness of neonatal jaundice treatment, shorten the treatment duration, protect liver and bile function, and effectively enhance neonatal immunity.

Funding

- (1) 2023 Innovation Fund Project for College Teachers of Gansu Provincial Department of Education (Project No. 2023B-004)
- (2) The Foundation of the First Hospital of Lanzhou University (Grant No. Idyyyn 2021-92)

Disclosure statement

The author declares no conflict of interest.

References

- [1] Liu L, 2023, Clinical Observation on Yinzhihuang Granules Combined with Bifidobacterium Triple Viable Powder and Phototherapy in the Treatment of Neonatal Jaundice. *Journal of Practical Traditional Chinese Medicine*, 39(11): 2172–2174.
- [2] Xiao Q, Guo N, 2023, Analysis of the Effect of Intravenous Albumin Combined with Yinzhihuang Granules in the Treatment of Neonatal Jaundice. *Shenzhen Journal of Integrated Traditional Chinese and Western Medicine*, 33(9): 16–19.
- [3] Zhou H, 2023, Analysis of the Efficacy of Yinzhihuang Granules Combined with Bifidobacterium Quadruple Viable Tablet in the Adjuvant Treatment of Neonatal Jaundice. *Modern Diagnosis and Treatment*, 34(7): 983–985.
- [4] Chen D, 2022, Clinical Effect of Yinzhihuang Granules Combined with Phototherapy in the Treatment of Neonatal

Jaundice in High-Altitude Areas. *Journal of Clinical Rational Drug Use*, 15(1): 119–121.

- [5] Zhu J, Liu Z, 2022, Effect of *Bacillus subtilis* Combined with Yinzhihuang Granules in the Treatment of Neonatal Jaundice. *Inner Mongolia Traditional Chinese Medicine*, 41(11): 22–23.
- [6] Zhao X, Chen X, Huang X, et al., 2021, Effect of Yinzhihuang Granules and *Bifidobacterium* Sachets Combined with Phototherapy on Neonatal Jaundice and Serum TRF and CRP Levels. *Hainan Medical Journal*, 32(15): 1986–1989.
- [7] Liang S, Wu S, 2023, Effect of Huanghuang Powder Fumigation Combined with Phototherapy and Yinzhihuang Granules in the Treatment of Neonatal Jaundice of the Damp-Heat Internal Syndrome. *Chinese National Medical Journal*, 35(20): 124–126.
- [8] Zou H, 2020, Clinical Effect of Intermittent and Continuous Phototherapy Combined with Yinzhihuang Granules in the Treatment of Neonatal Jaundice. *International Journal of Infectious Diseases (Electronic Edition)*, 9(2): 151.
- [9] Lu J, Li S, Mao Y, et al., 2023, Clinical Study on Yinzhihuang Granules Combined with *Bifidobacterium* Triple Viable Powder in the Treatment of Neonatal Pathological Jaundice. *New Chinese Medicine*, 55(20): 105–109.
- [10] Chen J, 2023, Observation on the Efficacy of Human Albumin Combined with Yinzhihuang Granules in the Adjunct Treatment of Neonatal Pathological Jaundice. *Journal of Practical Traditional Chinese Medicine*, 39(10): 1962–1964.

Publisher's note

Bio-Byword Scientific Publishing remains neutral with regard to jurisdictional claims in published maps and institutional affiliations.

The Role of Telemedicine in Transforming Palliative Nursing Care: Challenges and Implications for End-of-Life Care

Qianya Zhang*

Hong Kong Polytechnic University, Hong Kong 999077, China

*Corresponding author: Qianya Zhang, gjzxzqy@163.com

Copyright: © 2024 Author(s). This is an open-access article distributed under the terms of the Creative Commons Attribution License (CC BY 4.0), permitting distribution and reproduction in any medium, provided the original work is cited.

Abstract: Telemedicine is undoubtedly a powerful solution to transform nursing practices in palliative care, with a particular focus on improving care for terminally ill patients. This report highlights the value of telemedicine in end-of-life care by examining issues related to compensation, emphasizing communication and ethics, and addressing the social implications of the field. The telemedicine model of palliative services results in universally accessible healthcare that overcomes geographical barriers and provides equitable care. Additionally, it plays a crucial role in establishing better communication among healthcare team members, including doctors, patients, and patients' families, thus fostering collaboration and coordination in patient treatment and health management. Conversely, the challenges associated with technological obstacles and depersonalization due to digital interactivity require careful consideration. Socially, telemedicine may also exacerbate healthcare disparities, disproportionately impacting under-resourced and ethnic communities. Furthermore, the shift towards telecare may alter caregiver-patient relationships, as advancing technology could affect these dynamics unless the approach incorporates the patience and compassion essential in caregiving. Healthcare providers bear a social responsibility to ensure equitable access to telemedicine while upholding the fundamental principles of end-of-life care.

Keywords: Telemedicine; Palliative care; End-of-life care; Healthcare disparities; Communication in healthcare

Online publication: November 28, 2024

1. Introduction

End-of-life care nursing practices focus on providing holistic support for patients approaching the final stages of life ^[1]. This approach encompasses not only physical care but also emphasizes comprehensive support, addressing the emotional, spiritual, and psychosocial needs of patients and their loved ones. Telemedicine, as an innovative service model, holds the potential to transform patient care at this critical juncture. Telehealth

helps bridge gaps in care delivery, addressing geographical barriers that might otherwise necessitate the transfer of patients from their homes to medical facilities ^[2]. Integrating telemedicine into end-of-life nursing care requires careful examination of relevant technologies, regulatory frameworks, and ethical considerations. While telemedicine offers undeniable benefits for terminal care, certain challenges persist ^[3]. This essay aims to explore the various interconnected impacts of telemedicine on nursing practices within the end-of-life care setting.

2. Background information

End-of-life care often necessitates high-quality symptom management, emotional support, and efficient coordination of services. In the field of end-of-life nursing, telemedicine has demonstrated varied outcomes for both caregivers and patients, with each group experiencing distinct benefits ^[4]. Telemedicine offers patients and caregivers improved access to advanced palliative care, creating opportunities for specialized services, especially in remote or underserved areas. This enhanced accessibility allows patients to receive timely support while remaining in the comfort of their homes. Additionally, telemedicine empowers patients by providing greater control over their care, enabling informed decision-making and connections to essential support services ^[5]. The efficiency of service delivery is enhanced as the system streamlines care processes. By offering remote healthcare access, telemedicine broadens the availability of specialized care across diverse locations ^[6].

2.1. Current practices in end-of-life care

Understanding the current landscape of end-of-life care is essential for evaluating how telemedicine can advance this field ^[7]. This understanding requires an in-depth review of end-of-life care delivery across various settings, such as hospitals, hospices, and homes. It also involves examining the roles and collaborative responsibilities of healthcare professionals—including nurses, physicians, social workers, and spiritual care providers—in offering comprehensive palliative support. By highlighting both the benefits and areas for improvement in existing practices, healthcare stakeholders can assess whether telemedicine can achieve its intended outcomes and identify potential gaps ^[8]. This analysis takes into account the preferences and needs of terminal patients and their families, ensuring that telemedicine aligns with their expectations to foster a more supportive end-of-life care experience.

Telemedicine relies on technological innovations to enable remote interactions between patients and healthcare providers. Successful integration of telemedicine in end-of-life care requires assessing both technological proficiency and IT infrastructure readiness ^[9].

3. Body and discussion

3.1. Benefits of telemedicine in end-of-life care nursing practice

Telemedicine offers multiple advantages in end-of-life care nursing. First, it addresses challenges in providing palliative treatment by overcoming physical barriers and enabling patients to access specialized care regardless of location ^[10]. Recent studies indicate a significant rise in the use of telemedicine in palliative care—up to 71% between 2016 and 2020—underscoring its growing role as a key tool for ensuring quality care for terminally ill patients ^[11].

Additionally, telemedicine enhances communication among healthcare professionals, fostering more

effective collaboration ^[12]. Tools such as virtual consultations and telemonitoring improve teamwork by keeping healthcare providers informed and actively involved in decision-making, whether directly or through those utilizing the technology.

3.2. Technological barriers to telemedicine adoption

While telemedicine offers benefits in end-of-life care, its implementation faces technical challenges. Limited internet access remains a major issue, particularly in rural and underserved areas where high-speed infrastructure may be inadequate ^[13]. Furthermore, limited access to digital devices among patients and healthcare providers can hinder telemedicine adoption, as not everyone has access to computers, tablets, or smartphones for virtual consultations. Although telemedicine enables certain tasks to be conducted remotely, coordinating interactions across various platforms can result in interoperability issues, which disrupt clinical workflows and complicate data management ^[14].

These technological challenges raise critical concerns regarding the effectiveness and accessibility of telemedicine services. Individuals in remote areas with limited digital resources may struggle to access these services, contributing to healthcare disparities, while others may experience fewer obstacles ^[15]. Additionally, healthcare providers using e-health platforms may face difficulties in delivering quality care remotely, potentially impacting patient satisfaction and outcomes. Addressing these technological barriers requires collaborative efforts among policymakers, healthcare institutions, and technology providers to build essential infrastructure, promote digital literacy, and develop interoperable telemedicine models that meet the needs of both healthcare practitioners and patients ^[16].

3.3. Ethical considerations in telemedicine for end-of-life care

As telemedicine is increasingly integrated into end-of-life care in nursing, it introduces ethical dilemmas that necessitate careful consideration and thoughtful decision-making. One significant concern is patient autonomy in remote consultations, as physical distance may limit patients' ability to fully express preferences and advocate for their choices ^[17]. Privacy and confidentiality are equally critical, necessitating that telemedicine platforms incorporate robust security measures to protect sensitive health information shared in virtual sessions.

Informed consent is also essential in telemedicine, with healthcare providers responsible for clearly explaining the nature of remote consultations, including their benefits, limitations, and potential risks, to patients ^[18]. Discussing highly sensitive end-of-life topics, such as decisions on life-sustaining treatments, may also present ethical challenges. Compassionate and empathetic communication is vital, as doctors are provided the opportunity to maintain a respectful and supportive attitude when conducting these discussions with patients, keeping their emotional well-being in mind.

3.4. Quality of interpersonal interactions in telemedicine

Telemedicine, while enhancing care quality, can complicate interpersonal interactions, especially in end-of-life care. During remote consultations, both physical distance and the absence of nonverbal cues can impact rapport and empathy between healthcare providers, patients, and their families ^[19]. Miscommunication and the lack of nonverbal signals—such as tone, facial expressions, and body language—may lead to misunderstandings and a reduced sense of connection with patients.

Despite these challenges, supporting patients' well-being through telemedicine remains achievable.

Healthcare professionals can prioritize honing effective communication skills, such as active listening and expressing empathy and compassion, to convey support within virtual interactions ^[20].

3.5. Strategies to optimize telemedicine implementation in end-of-life care settings

A key factor in supporting telemedicine for end-of-life care is investing in infrastructure to improve internet connectivity. This initiative is essential for effective telemedicine integration, as broadband expansion benefits not only job opportunities but also access to educational resources, especially in underserved areas ^[21]. Additionally, promoting digital literacy among both patients and healthcare providers is crucial to ensuring that all participants can effectively navigate telemedicine technologies.

Comprehensive training and education programs are fundamental to enhancing telemedicine expertise and addressing ethical considerations in end-of-life care. Training efforts should focus on familiarizing healthcare teams with telemedicine platforms, communication protocols for virtual interactions, and strategies to maintain patient-centered care remotely ^[22].

3.6. Pros and cons of new improvements

The inclusion of telemedicine as a pathway for enhanced care in end-of-life settings presents both advantages and challenges, with social impacts stemming from its adoption. While telemedicine improves accessibility to medical care—especially for individuals in remote areas, thereby addressing healthcare disparities—it also enables patients to exercise ownership over their care and engage in self-management through remote consultations and decision-making. However, issues such as technological barriers and potential disconnection in virtual communications must be considered.

From a social perspective, the digital divide affecting individuals who lack literacy skills or access to technology may be exacerbated, indicating the need for equitable implementation. This shift in caregiver-patient dynamics may also affect the emotional support provided through end-of-life care. Clinicians in the healthcare sector must uphold the importance of ensuring equitable access to telemedicine and maintaining compassionate practices, as is the standard in other areas of end-of-life care.

4. Significance of research

This research represents a significant advancement in preventive strategies within end-of-life care in nursing practice. By acknowledging the potential for innovation and addressing key challenges, it contributes meaningfully to the palliative care sector by enhancing service quality and accessibility, ultimately aiming to improve healthcare standards ^[23]. Additionally, the right-to-die movement emphasizes the importance of integrating technology into holistic care models, supporting person-centered care, and enriching patients' final experiences with their families ^[24]. In this context, the research informs healthcare policy, strengthens clinical practice, and promotes educational initiatives that facilitate the effective adoption of telemedicine, ensuring optimal care delivery and patient convenience at the end of life.

5. Conclusion

Telemedicine brings substantial benefits that enhance end-of-life care nursing. Despite existing challenges,

its value remains evident for two primary reasons: it expands patient access to palliative care and improves communication among healthcare professionals, thereby empowering patients in their care journey. However, complex technological, regulatory, and ethical considerations must be resolved for telemedicine to be effectively integrated into end-of-life care. Nurses play a vital role in delivering compassionate, holistic care for terminally ill patients and can significantly impact this field by combining telemedicine capabilities with innovative approaches.

Disclosure statement

The author declares no conflict of interest.

References

- [1] Gonella S, Basso I, Clari M, et al., 2021, A Qualitative Study of Nurses' Perspective About the Impact of End-of-Life Communication on the Goal of End-of-Life Care in Nursing Home. *Scand J Caring Sci*, 35(2): 502–511. <https://doi.org/10.1111/scs.12862>
- [2] Zanjani A, Giebink B, Woods K, et al., 2020, Whitepaper: Telemental Health and the COVID-19 Behavioral Health Crisis. Behavioral Health Facility Consulting, viewed October 10, 2024, <https://www.bhfellc.com/post/whitepaper-telemental-health-and-the-covid-19-behavioral-health-crisis>
- [3] Santos FD, 2021, The Triumph and Challenges Created by the Idea of Progress, in *Time, Progress, Growth and Technology: How Humans and the Earth are Responding*. Springer, Cham, 191–326. https://doi.org/10.1007/978-3-030-55334-0_5
- [4] Steindal SA, Nes AAG, Godskesen TE, et al., 2020, Patients' Experiences of Telehealth in Palliative Home Care: Scoping Review. *J Med Internet Res*, 22(5): e16218. <https://doi.org/10.2196/16218>
- [5] Vainauskienė V, Vaitkienė R, 2021, Enablers of Patient Knowledge Empowerment for Self-Management of Chronic Disease: An Integrative Review. *Int J Environ Res Public Health*, 18(5): 2247. <https://doi.org/10.3390/ijerph18052247>
- [6] Sageena G, Sharma M, Kapur A, 2021, Evolution of Smart Healthcare: Telemedicine During COVID-19 Pandemic. *J Inst Eng India Ser B*, 102(6): 1319–1324. <https://doi.org/10.1007/s40031-021-00568-8>
- [7] Mills J, Fox J, Damarell R, et al., 2021, Palliative Care Providers' Use of Digital Health and Perspectives on Technological Innovation: A National Study. *BMC Palliat Care*, 20(1): 124. <https://doi.org/10.1186/s12904-021-00822-2>
- [8] Smith NR, Knocke KE, Hassmiller Lich K, 2022, Using Decision Analysis to Support Implementation Planning in Research and Practice. *Implement Sci Commun*, 3(1): 83. <https://doi.org/10.1186/s43058-022-00330-1>
- [9] Tian Y, Zhang Y, Cheng Q, et al., Information and Communication Technology Based Integrated Care for Older Adults: A Scoping Review. *Int J Integr Care*, 23(2): 2. <https://doi.org/10.5334/ijic.6979>
- [10] Wang N, 2023, *Connecting Care: Life, Movement and Circulation in the Hospice*, dissertation, University of British Columbia.
- [11] Frydman JL, Berkalieva A, Liu B, et al., 2022, Telemedicine Utilization in the Ambulatory Palliative Care Setting: Are There Disparities? *J Pain Symptom Manage*, 63(3): 423–429. <https://doi.org/10.1016/j.jpainsymman.2021.09.019>
- [12] Nyame-Asiamah F, 2020, Improving the “Manager-Clinician” Collaboration for Effective Healthcare ICT and Telemedicine Adoption Processes – A Cohered Emergent Perspective. *Information Technology for Development*,

- 26(3): 525–550. <https://doi.org/10.1080/02681102.2019.1650326>
- [13] Yaacoub E, Alouini MS, 2020, A Key 6G Challenge and Opportunity—Connecting the Base of the Pyramid: A Survey on Rural Connectivity. *Proceedings of the IEEE*, 108(4): 533–582. <https://doi.org/10.1109/JPROC.2020.2976703>
 - [14] Record JD, Ziegelstein RC, Christmas C, et al., 2021, Delivering Personalized Care at a Distance: How Telemedicine Can Foster Getting to Know the Patient as a Person. *J Pers Med*, 11(2): 137. <https://doi.org/10.3390/jpm11020137>
 - [15] Lopez AM, Lam K, Thota R, 2021, Barriers and Facilitators to Telemedicine: Can You Hear Me Now? *Am Soc Clin Oncol Educ Book*, 41: 25–36. https://doi.org/10.1200/EDBK_320827
 - [16] Chen ZS, Ruan JQ, 2024, Metaverse Healthcare Supply Chain: Conceptual Framework and Barrier Identification. *Engineering Applications of Artificial Intelligence*, 133(A): 108113. <https://doi.org/10.1016/j.engappai.2024.108113>
 - [17] Enam A, Dreyer HC, De Boer L, 2022, Individuals' Perceptions as a Substitute for Guidelines and Evidence: Interview Study Among Clinicians on How They Choose Between In-Person and Remote Consultation. *JMIR Form Res*, 6(5): e35950. <https://doi.org/10.2196/35950>
 - [18] Keenan AJ, Tsourtos G, Tieman J, 2022, Promise and Peril-Defining Ethical Telehealth Practice from the Clinician and Patient Perspective: A Qualitative Study. *Digit Health*, 8: 20552076211070394. <https://doi.org/10.1177/20552076211070394>
 - [19] Defauwes B, 2022, Connecting at a Distance: Fostering Empathy in Remote Healthcare Applications, dissertation, Utrecht University.
 - [20] Tan L, Le MK, Yu CC, et al., 2021, Defining Clinical Empathy: A Grounded Theory Approach from the Perspective of Healthcare Workers and Patients in a Multicultural Setting. *BMJ Open*, 11(9): e045224. <https://doi.org/10.1136/bmjopen-2020-045224>
 - [21] Cullinan J, Flannery D, Harold J, et al., 2021, The Disconnected: COVID-19 and Disparities in Access to Quality Broadband for Higher Education Students. *Int J Educ Technol High Educ*, 18(1): 26. <https://doi.org/10.1186/s41239-021-00262-1>
 - [22] Robinson VC, 2023, Opportunities for Improving Communication Between Maryland Nurses and Black Maternal Health Patients, dissertation, Walden University.
 - [23] Abel J, Kellehear A, Mills J, et al., 2021, Access to Palliative Care Reimagined. *Future Healthc J*, 8(3): e699–e702. <https://doi.org/10.7861/fhj.2021-0040>
 - [24] Bond SM, Castle JE, Uveges MK, et al., 2022, Nursing Ethics and Advanced Practice: Palliative and End-of-Life Care Across the Lifespan, in *Nursing Ethics and Professional Responsibility in Advanced Practice* (4th edition). Jones & Bartlett Learning, Burlington, 426.

Publisher's note

Bio-Byword Scientific Publishing remains neutral with regard to jurisdictional claims in published maps and institutional affiliations.

Medication Selection and Nursing Interventions for Parkinson's Disease Patients

Qian Lv^{1*}, Yingying Li¹, Xiujuan Wei²

¹Qilu Institute of Technology, Jinan 250200, Shandong Province, China

²Mianyang Wanjiang Eye Hospital, Mianyang 621000, Sichuan Province, China

**Corresponding author:* Qian Lv, lqlvqian_123@163.com

Copyright: © 2024 Author(s). This is an open-access article distributed under the terms of the Creative Commons Attribution License (CC BY 4.0), permitting distribution and reproduction in any medium, provided the original work is cited.

Abstract: Parkinson's disease is a neurodegenerative disorder that significantly impacts patients' lives. Currently, treatment primarily relies on drug therapy, while effective nursing interventions can help mitigate adverse reactions associated with medication use. This article reviews medication selection and nursing interventions for patients with Parkinson's disease, aiming to alleviate symptoms, improve quality of life, and provide a scientific and comprehensive basis for medication and clinical nursing practices.

Keywords: Parkinson's disease; Medication analysis; Nursing interventions

Online publication: November 28, 2024

1. Introduction

Parkinson's disease (PD) is a chronic, progressive neurodegenerative disorder of the central nervous system, also referred to as parkinsonism. Parkinsonism commonly affects individuals aged 50–65 years, with clinical manifestations divided into motor and non-motor symptoms. Motor symptoms include resting tremors, bradykinesia, muscle rigidity, and abnormal posture and gait, while non-motor symptoms involve sensory disturbances ^[1,2]. In China alone, approximately 2.5 million individuals are affected by PD, and with the aging population, the prevalence continues to rise, significantly impacting patients' quality of life ^[3]. The pathogenesis of PD is complex and not fully understood; however, reduced dopamine secretion in the brain is believed to be a central factor. Therefore, PD treatment typically targets dopamine pathways and includes medications such as levodopa, dopamine agonists, enzyme degradation inhibitors, and central cholinergic drugs. Additionally, implementing nursing measures can effectively slow the progression of PD. This article summarizes medication approaches and essential nursing practices in the treatment of PD, providing guidance for optimizing patient care and enhancing patients' quality of life.

2. Clinical medication analysis of Parkinson's disease

In PD, the pathological state is characterized by decreased dopamine levels in the substantia nigra and striatum, as well as the accumulation of α -synuclein in the brain, which leads to Lewy body formation and further neuronal damage. Additionally, the reduction in dopamine causes cholinergic nerve function to become relatively dominant, resulting in muscle rigidity during movement ^[6]. Therefore, dopamine supplementation is a crucial therapeutic approach, and appropriately reducing cholinergic nerve activity can also effectively alleviate symptoms.

2.1. Dopamine prodrugs

Levodopa is a common dopamine precursor used to treat PD. Levodopa effectively crosses the blood-brain barrier into the central nervous system, where it is absorbed by dopaminergic neurons and converted to dopamine, thus compensating for the dopamine deficiency in the brain ^[4]. After conversion, dopamine plays an essential role in regulating the striatum, promoting striatal function recovery, and improving motor dysfunction. Enhanced neural communication results in more flexible and coordinated movement, helping alleviate gait instability and abnormal posture in PD patients.

This medication, which directly increases dopamine levels in the central nervous system, is indispensable in treating most PD patients. Typically administered in low doses and gradually increased as needed, levodopa can cause side effects with long-term use, including nausea, vomiting, anorexia, constipation, and cardiovascular issues such as orthostatic hypotension and arrhythmia. Therefore, it is critical to adhere to the recommended dosage and schedule and to monitor for possible side effects. To reduce adverse effects, levodopa is often combined with receptor agonists and monoamine oxidase inhibitors in clinical practice. For instance, Sinemet, a controlled-release tablet with carbidopa, enhances levodopa's bioavailability in the central nervous system by blocking its peripheral metabolism, thus reducing side effects ^[5]. Madopar, a combination of levodopa and benserazide, improves levodopa's efficacy, prolongs patients' symptom-free intervals, and delays the onset of PD symptoms.

2.2. Dopamine receptor agonists

Dopamine agonists mimic dopamine by binding to central nervous system receptors, stimulating them to enhance dopamine's effects. Clinically, dopamine agonists are divided into ergot and non-ergot categories, with non-ergot agonists such as pramipexole, ropinirole, and rotigotine often preferred for safety ^[6]. However, as the disease progresses, their efficacy may diminish compared to levodopa, and side effects like motor and neurological dysfunction can arise. Therefore, they are commonly used as adjunct therapies to levodopa.

2.3. Inhibitors of dopamine-degrading enzymes

After dopamine is released in the central nervous system, most of it is reabsorbed at nerve endings by the dopamine transporter (DAT) and is subsequently degraded by monoamine oxidase (MAO) and catechol-O-methyltransferase (COMT) before being excreted in the urine ^[7]. Inhibiting these degrading enzymes to increase dopamine concentration is an effective strategy for slowing PD progression. Selegiline, a selective MAO-B inhibitor, inhibits MAO-B activity, reducing dopamine degradation at the presynaptic membrane, increasing dopamine concentration in the synaptic cleft, and prolonging dopamine's action time. COMT is another enzyme involved in dopamine degradation, acting by inhibiting COMT activity to slow dopamine degradation.

However, compared to MAO-B inhibitors, COMT inhibitors are used less frequently in clinical practice. The use of enzyme inhibitors slows down dopamine degradation in the brain, increases dopamine concentration in the synaptic cleft, and prolongs dopamine's duration of action, which can help alleviate PD symptoms. However, this can also prolong levodopa's side effects and increase liver toxicity and other adverse effects ^[8]. Consequently, these inhibitors are often used as adjunctive therapies with levodopa rather than as standalone treatments.

2.4. Central cholinergic agents

Recent studies suggest that reducing cholinergic receptor activity in the central nervous system may alleviate PD symptoms ^[9]. Anticholinergic drugs help restore the dopamine-acetylcholine balance by inhibiting acetylcholine activity, thereby improving PD symptoms. Benzhexol, for instance, is effective in treating Parkinsonian tremors and is widely used in PD management. Due to potential side effects, it is essential to closely monitor patients and adjust dosages or medications as needed.

2.5. New drugs for central neuroprotection

Research indicates that abnormal α -synuclein accumulation can damage the central nervous system, while glucocerebrosidase (GBA) gene mutations may reduce lysosomal activity, impair mitophagy, and promote neurotoxic α -synuclein oligomer formation, worsening PD progression. Approaches like α -synuclein clearance through monoclonal antibodies and inhibitors that prevent α -synuclein misfolding have shown promise in slowing PD progression. Glucoside-targeted drugs have demonstrated efficacy in preclinical studies, while neuroprotective agents such as glucagon-like peptide-1 receptor agonists and antioxidants play a vital role in maintaining neurological function.

2.6. Therapeutic application of traditional Chinese medicine

While Western treatments for PD have yielded considerable results, they primarily focus on symptom management rather than halting disease progression. Long-term drug use can also lead to increased dosage requirements and aggravated side effects, making treatment more challenging in the middle and late stages of PD. Traditional Chinese medicine (TCM) offers a new therapeutic direction, with benefits like stable efficacy, lasting effects, and low toxicity.

In early treatment, TCM's preventive approach can help slow disease progression. *Cistanche deserticola*, for instance, has been shown to tonify kidney yang, nourish essence and blood, and improve intestinal motility, helping to increase dopamine content in the brain and prevent the loss of dopaminergic nerve endings in the striatum. Additionally, TCM can reduce adverse reactions associated with levodopa. In mid-stage treatment, combining TCM with Western medications enhances efficacy, minimizes side effects and dependency, and maximizes therapeutic benefits. For example, tetrandrine not only promotes dopamine secretion but also exhibits anticholinergic effects, supporting PD management across disease stages ^[10].

3. Basic care for Parkinson's disease

3.1. Medication care

Patients in the early and middle stages of PD often rely primarily on drug therapy. However, commonly used

drugs in clinical practice can have varying degrees of side effects, so nurses should closely monitor the patient's condition, strictly adhere to the medication plan ^[11], and guide patients in proper medication use. Dopamine drugs should be administered one hour before meals or two hours after meals to avoid interference from food protein with drug absorption ^[12]. The “switch” effect and “end-of-dose” phenomenon ^[13] associated with this type of medication require careful monitoring for any adverse reactions. Should these reactions occur, nurses must promptly communicate with the physician to adjust the drug dose or medication regimen. In long-term care, it is essential to monitor and address the potential side effects of anticholinergic and other medications on the central nervous and motor systems ^[14]. Patient medication and symptom changes should be documented in a timely manner to support physicians in making necessary treatment adjustments.

3.2. Surgical care

When PD advances and as necessary, surgical intervention may effectively slow disease progression. Comprehensive intraoperative nursing care provides essential support to ensure optimal outcomes during and after surgery. Whole-process nursing is based on the principles of nursing science, offering holistic care that addresses both physiological and psychological needs according to the patient's specific situation. Prior to surgery, patient records are organized and information consolidated to establish a thorough understanding of the patient's condition, facilitating further treatment planning. Intraoperative care is critical for the smooth progress of the operation and for minimizing postoperative complications. Postoperative nursing includes recovery care, rehabilitation, and psychological support, which help mitigate the physical and emotional impacts of surgery and promote patient recovery.

3.3. Condition monitoring

Nursing care should prioritize monitoring changes in symptoms such as tremors, muscle rigidity, bradykinesia, and the emergence of any new symptoms. Regular neurological assessments, including evaluations of muscle strength, muscle tone, sensory function, and reflexes, should be conducted to comprehensively assess the patient's neurological status. Cognitive assessments using tools such as the Mini-Mental State Examination are important to evaluate cognitive function, observe emotional changes, and identify psychological issues such as depression or anxiety in a timely manner. Monitoring the effects and side effects of drug therapy is also essential; improvements in symptoms, as well as side effects like nausea, vomiting, and orthostatic hypotension, should be closely observed.

3.4. Psychological care

Patients with PD frequently experience emotional disorders, including depression and anxiety. Neuroendocrine changes, neurological deficits, and cognitive impairment due to brain tissue damage contribute to these emotional challenges ^[15]. Family members and healthcare providers should offer care and support while monitoring the patient's emotional well-being. Psychological counseling and family support can help patients build confidence, re-establish self-worth and social identity, and reduce their psychological burden.

3.5. Family care

Family members play a crucial role in the treatment process. Nutritional support, regular routines, and dietary management can help minimize the occurrence of constipation in patients. Rehabilitation exercises encourage

patients to engage in appropriate physical activity and training to improve motor function and relieve symptoms.

4. Conclusion

Parkinson's disease is a prevalent neurodegenerative disorder with a rising incidence among middle-aged and elderly populations. Its complex mechanisms, prolonged course, and lack of an effective cure make both treatment and prevention challenging. Current drug therapies have significant limitations in managing symptoms and alleviating patients' physical and psychological conditions. Therefore, only through strengthened and standardized drug therapy, along with effective nursing support, can the efficacy of treatment be optimally enhanced. This article reviews the treatment and nursing care of Parkinson's disease, focusing on medication management and disease care, to provide patients with scientific and practical guidance for treatment selection, medication, and disease management. Currently, drug therapy remains the primary treatment choice. However, future directions will likely include developing new therapeutic targets, broadening the combined use of traditional Chinese and Western medicine, and minimizing the side effects of long-term medication. Implementing effective nursing strategies to support and ensure medication efficacy is also a valuable approach to improving symptoms in PD patients.

Disclosure statement

The authors declare no conflict of interest.

References

- [1] Liu X, 2021, Electroacupuncture Retards the Progression of Alzheimer's Disease by Regulating Cell Autophagy, Glucose Metabolism, and Ferroptosis Through Long Non-Coding RNA SNHG1 and Its Mechanism, dissertation, Nanchang University.
- [2] Lin P, Liang J, Guan Y, et al., 2023, Research Progress on the Mechanism of Traditional Chinese Medicine in Prevention and Treatment of Parkinson's Disease. *Guangxi Traditional Chinese Medicine*, 46(4): 71–74.
- [3] Zhen J, Zheng X, Wu J, 2020, Research Progress of Human Induced Pluripotent Stem Cells in the Treatment of Parkinson's Disease. *Journal of Stroke and Neurological Disease*, 37(1): 84–86.
- [4] Liu Y, Ma K, 2021, Progress of Drug Therapy in Different Stages of Parkinson's Disease. *Chinese Medicine Review*, 40(6): 758–764.
- [5] Wang X, 2022, Effects of Daidzein on Neuroinflammation and Oxidative Stress and Its Mechanism, dissertation, Hefei University of Technology.
- [6] Pang W, Zhai L, Liu Y, et al., 2021, Analysis of Global Guidelines for Comprehensive Treatment of Parkinson's Disease. *Chinese Journal of Clinical Pharmacology*, 38(21): 2638–2643.
- [7] Sun J, Xiong H, Yao Y, 2020, Advances in the Treatment of Parkinson's Disease. *Medical Review*, 26(6): 1157–1160 + 1165.
- [8] Chen F, 2020, Current Status and Progress of Diagnosis and Treatment of Parkinson's Disease. *Medical Information*, 33(12): 43–46.
- [9] Sun W, Bi H, 2021, Research Progress of Parkinson's Disease in Traditional Chinese and Western Medicine. *Modern Journal of Integrated Traditional Chinese and Western Medicine*, 31(16): 2321–2325.

- [10] Zhang C, Zhang H, Qu C, et al., 2014, Bushen Tongluo Capsule Combined with Madopar in the Treatment of Advanced Parkinson's Disease: A Clinical Study. *Chinese Patent Materia Medica*, 36(2): 263–265.
- [11] Wang R, 2013, Nursing Experience of Patients with Parkinson's Disease. *Guangming Traditional Chinese Medicine*, 28(9): 1924–1925.
- [12] Gao G, 2004, The Key Points in the Diagnosis and Treatment of Parkinson's Disease. Jiangsu Science and Technology Press, Nanjing, 267.
- [13] Liu C, Huang X, 2018, Research on the Academic Origin and Development of the Etiology, Pathogenesis, and Treatment Principles of Parkinson's Disease. *Beijing Traditional Chinese Medicine*, 37(8): 780–784.
- [14] Li H, Wang H, Bian C, et al., 2002, Nursing Experience of Elderly Patients with Parkinson's Disease. *Journal of Chengde Medical College*, 19(4): 299.
- [15] Luo X, Li Z, Zhu M, et al., 2021, Expert Consensus on Clinical Diagnosis and Treatment of Parkinson's Disease with Traditional Chinese Medicine. *Chinese Journal of Medicine*, 62(23): 2109–2116.

Publisher's note

Bio-Byword Scientific Publishing remains neutral with regard to jurisdictional claims in published maps and institutional affiliations.

Analysis of the Causes of Insomnia in Young and Middle-aged People and Nursing Intervention Strategies of Traditional Chinese and Western Medicine

Weifeng Chen^{1,2}, Yanyan Qin^{1*}, Cheng Cheng^{1,3}, Xiaojia Zhou^{1,4}

¹School of Medical Technology and Nursing, Shenzhen Polytechnic University, Shenzhen 518055, Guangdong Province, China

²Zhuhai Liuhe Dental Clinic, Zhuhai 519000, Guangdong Province, China

³Shenzhen Hospital of Traditional Chinese Medicine, Shenzhen 518000, Guangdong Province, China

⁴Longgang District People's Hospital of Shenzhen, Shenzhen 518172, Guangdong Province, China

*Corresponding author: Yanyan Qin, qyy@szpu.edu.cn

Copyright: © 2024 Author(s). This is an open-access article distributed under the terms of the Creative Commons Attribution License (CC BY 4.0), permitting distribution and reproduction in any medium, provided the original work is cited.

Abstract: *Objective:* To examine insomnia in the modern young and middle-aged population and explore nursing intervention strategies using traditional Chinese and Western medicine. *Methods:* A total of 255 inpatients and outpatients were sampled from Shenzhen Hospital of Traditional Chinese Medicine. The Sleep Questionnaire for Young and Middle-aged People was used to assess insomnia, and a linear regression model was applied for data analysis. *Results:* A total of 251 valid questionnaires were collected. Correlation analysis revealed a high incidence of insomnia among respondents. Linear correlation analysis indicated that mental illness or other underlying diseases leading to pain had a significantly positive effect on symptom improvement through Chinese and Western medicine treatments ($B = 0.763$, $P < 0.01$). Conversely, work or life pressures (emotional or financial issues) had a significantly negative impact on treatment effectiveness ($B = -0.503$, $P < 0.01$). Cross-analysis identified high life or work pressure as the primary cause of insomnia (70.1%). *Conclusion:* Insomnia is prevalent among the young and middle-aged in modern times, with high work or life pressure being the leading factor.

Keywords: Young and middle-aged; Insomnia; Traditional Chinese and Western medicine nursing; Intervention strategy

Online publication: November 28, 2024

1. Introduction

Insomnia is a condition characterized by difficulty in falling asleep naturally. It refers to the subjective experience of patients who are dissatisfied with the duration and quality of their sleep, impacting their daytime

work and life. Common symptoms include difficulty falling asleep, poor sleep quality, memory issues, and lack of concentration. Based on the cause, insomnia can be classified into two categories: primary and secondary ^[1].

Insomnia is one of the most common sleep problems. Epidemiological studies indicate that up to half of the population reported experiencing varying levels of sleep problems in a sleep quality survey conducted in the past month. Long-term insomnia not only significantly affects normal work and life but also increases the risk of further health complications. To standardize insomnia diagnosis and treatment in China, the “Chinese Expert Consensus on Definition, Diagnosis, and Drug Treatment of Insomnia” was published by a group of field professionals in 2006. This was followed by the “Chinese Adult Insomnia Diagnosis and Treatment Guidelines” launched in 2012 ^[1]. This guideline provides a more comprehensive and standardized approach to the diagnosis and treatment of insomnia in clinical practice. Standards for insomnia diagnosis and treatment, as well as international classifications, have also evolved over the years, adapting to new drugs, and domestic practices are continually refined based on clinical experience.

Sleep is essential to maintaining the body’s basic physiological functions, and sleep quality directly affects people’s health and quality of life. Standard sleep duration is about seven to eight hours per day, meaning that people spend about one-third of their lives sleeping, which is crucial for organ repair. Quality sleep promotes brain cell recovery and function, keeping individuals energetic, and improving learning and work efficiency. Modern scientific research has shown that quality sleep positively affects memory and can even enhance memory function during the day. It can be said that sleep is closely related to people’s health.

Jing Yue Quanshu states: “Worry, fatigue, panic, and worry lead to sleeplessness, which often relates to a deficiency of true Yin and blood; Yin and Yang become imbalanced, causing restlessness” ^[2]. Thus, long-term insomnia can significantly impact physical and mental health. Insomnia can lead to daytime drowsiness, reduced physical function, and symptoms like nervousness, depression, and low mood. Prolonged insomnia may result in multi-system dysfunction, such as changes in immune function, emotional control disorders, and gastrointestinal dysfunction. In severe cases, it can lead to memory disorders, cognitive impairment, and difficulties in thinking. Common complications include obesity, diabetes, and high blood pressure. The effects of long-term insomnia on physical and mental health are substantial, making timely control and treatment essential.

The rapid increase in insomnia cases not only affects individual health but also contributes to social issues. According to global research by medical experts, modern economic development and the faster pace of work and life have led conditions like dementia, schizophrenia, and depression to become prevalent diseases with significant social and economic impacts, profoundly affecting personal and family life. The increased prevalence of these conditions is closely linked with insomnia, highlighting the importance of addressing it positively and proactively.

Insomnia remains a widespread concern. Generally, combined intervention research using both Chinese and Western medicine is limited. Therefore, studying the causes of insomnia in contemporary young and middle-aged people and exploring combined traditional Chinese and Western medicine intervention strategies is essential. This study mainly analyzes the primary factors influencing insomnia in young and middle-aged adults and proposes appropriate nursing intervention strategies using both traditional Chinese and Western medicine to alleviate insomnia and promote mental and physical health.

2. Methods

2.1. Survey subjects and content

2.1.1. Respondents

In this study, a random sampling method was used to conduct an online questionnaire survey at Shenzhen Traditional Chinese Medicine Hospital. This study was examined and approved by the ethics committee of Shenzhen Hospital of Traditional Chinese Medicine, China.

2.1.2. Survey content

A total of 255 questionnaires were distributed in this survey, and 251 questionnaires were returned, with a response rate of 98.4%. A total of 251 valid questionnaires were collected, achieving an effective rate of 100%. The main content of the survey included:

- (1) Respondents' ages (under 29, 30-39, 40-49, 50 years or older).
- (2) Factors contributing to insomnia (sleep duration, sleep onset time, pre-sleep activities, insomnia frequency).
- (3) Main reasons for insomnia (high work pressure, sleep environment, irregular work and rest schedules, diet, illness, and other factors).
- (4) Improvement status after TCM treatment at our hospital (significant improvement, slight improvement, or no improvement).

2.2. Data entry and analysis

2.2.1. Data entry

After completing the questionnaire collection, the three team members checked the data for completeness and accuracy, exported and organized the validated data, and entered it independently by two individuals. The data were statistically analyzed; after a final data check, they were imported into Excel and analyzed using SPSS26.0. Excel and Word were used to generate the required data visualizations.

2.2.2. Statistical analysis method

All data were double-entered into the computer by two individuals, and statistical analysis was performed using SPSS26.0 software. Chi-squared tests were used for categorical data, with $P < 0.05$ considered statistically significant.

2.3. Traditional Chinese and Western medicine treatment methods

For hospitalized patients, various therapies were administered, and their effects were observed, including drug therapy, transcranial magnetic therapy, cupping, gua sha, ear bean therapy, Chinese medicine acupuncture point patches, traditional Chinese medicine pillows, Chinese medicine foot baths, and Chinese medicine fumigation therapy.

3. Results

3.1. Analysis of the age proportion of subjects

A total of 251 patients were surveyed, all of whom were young and middle-aged. Among them, 166 patients were aged 29 years or below, accounting for 66.1%; 31 were aged 30 to 39, accounting for 12.4%; 28 were aged 40 to 49, accounting for 11.2%; and 26 were aged 50 or older, accounting for 10.4%. (See **Table 1**).

Table 1. Age proportion of patients

Age	Number of people	Proportion
Under 29	166	66.1%
Age 30–39	31	12.4 %
Age 40–49	28	11.2 %
Over 50	26	10.4%

3.2. Linear regression models

Table 2. Linear regression models

Model	Unstandardized coefficients		Significance	Collinearity statistics
	B	S.E.		VIF
(Constant)	2.312	0.545	0.000	
High stress at work or life (emotional or financial problems)	-0.503	0.168	0.003	1.017
Irregular schedules	-0.205	0.163	0.211	1.047
Eating problems (e.g., coffee drinking, late-night snacks)	-0.063	0.154	0.685	1.003
Sleep environment	0.086	0.154	0.579	1.021
Pain and difficulty sleeping due to mental or other diseases	0.763	0.163	.000	1.053
R^2			0.141	
F			8.036	
P			< 0.001	

Dependent variable: whether the symptoms were improved by traditional Chinese and Western medicine treatment (for inpatients)

Table 2 shows the linear regression model of this study and the following results were found:

- (1) The fit of the linear regression model was low ($R^2 = 0.141 < 0.6$), meaning the results did not fully reflect the effects of variables such as work or life pressure (emotional or financial issues), irregular schedules, dietary habits (e.g., coffee consumption or late-night eating), sleep environment, and mental or other underlying diseases on the improvement in insomnia symptoms through Chinese and Western medicine treatment.
- (2) VIF values were all below 5, indicating no multicollinearity among the five independent variables.
- (3) The regression equation was significant ($F = 8.036$, $P < 0.001$), indicating that at least one of the five independent variables significantly affects the treatment effect of traditional Chinese and Western medicine.
- (4) Pain and insomnia caused by mental or other underlying diseases had a significant positive impact on the improvement effect of TCM and Western medicine on insomnia symptoms ($B = 0.763 > 0$, $P < 0.01$). High work or life stress (emotional or financial problems) had a significant negative impact on the improvement effect of TCM and Western medicine on insomnia symptoms ($B = -0.503 < 0$, $P < 0.01$).

3.3. Analysis of results

3.3.1. Cross-analysis of insomnia frequency and age

Results showed that of 166 individuals under the age of 29, 9 (3%) had insomnia almost every day. In the 30–39 age group, 5 (16.1%) had insomnia almost every day; among the 28 individuals aged 40–49, 3 (10.7%) had insomnia almost every day. Among the 26 individuals over 50, 6 (23%) had insomnia almost every day. Analysis revealed that 46 individuals under 29 almost never had insomnia, a large proportion (27%), while the highest proportion of daily insomnia was among those over 50 (23%) (see **Table 3**). Chi-squared analysis showed a significant association between age and insomnia frequency ($\chi^2 = 43.391$, $P < 0.01$), indicating a significant correlation between age and frequency of insomnia.

Table 3. Insomnia frequency cross-analysis by age

Age	Frequency of insomnia					Total
	Almost every day	3–4 times a week	Once or twice a week	Once or twice a month	None/almost none	
Under 29	9	11	46	54	46	166
Age 30–39	5	7	11	4	4	31
Age 40–49	3	4	12	4	5	28
Over 50	6	8	8	4	0	26
Total	23	30	77	66	55	251

3.3.2. Analysis of main causes of insomnia

According to the results, the primary causes of insomnia were: high work or life stress (emotional or financial issues) in 176 cases (70.1%); irregular schedules in 162 cases (64.5%); dietary habits (e.g., coffee drinking, late-night eating) in 108 cases (43.0%); sleep environment issues in 121 cases (48.2%); and pain or difficulty sleeping due to mental or other underlying diseases in 90 cases (35.9%). Other causes accounted for 5 cases (2.0%). Thus, work or life stress was the most common cause (see **Table 4**).

Table 4. Analysis of influencing factors of insomnia

Causes of insomnia	Number of people	Proportion
Work or life stress (emotional or financial problems)	176	70.1%
Irregular schedules	162	64.5%
Eating problems (e.g., coffee drinking, late-night snacks)	108	43.0%
Sleep environment	121	48.2%
Pain and difficulty sleeping due to mental or other diseases	90	35.9%
Others	5	2.0%

3.3.3. Analysis of improvement in patients treated with traditional Chinese and Western medicine

The integrated treatment methods in this study included drug therapy, transcranial magnetic therapy, cupping, scraping, ear acupoint pressure with beans, acupuncture point patches, traditional medicine pillows, foot baths, and fumigation. After treatment, 140 patients were surveyed regarding improvement. Among hospitalized patients, 69 (49.2%) showed great improvement, 57 (40.7%) showed slight improvement, and 14 (10%)

showed no improvement. The majority of hospitalized patients (49.2%) reported significant improvement after treatment with traditional Chinese and Western medicine (see **Table 5**).

Table 5. Improvement in treatment with traditional Chinese and Western medicine

Symptom improvement	Number of people	Proportion
Great improvement	69	27.5%
Slight improvement	57	22.7%
No improvement	14	5.6%
Non-hospitalized patients	111	44.2%

4. Discussion

From the perspective of Western medicine, neurosis is a temporary disorder of brain function, with sleep disorder being one of its main symptoms, and there is no proven organic disease as the basis. The etiology is primarily related to psychosocial stress and personality traits, and the course of the disease is prolonged, often recurring due to life events ^[3]. From the perspective of traditional Chinese medicine (TCM), insomnia is referred to as “insomnia” (失眠). Modern factors, irregular diets, and overwork can lead to dysfunction of the viscera, causing blood stasis, an imbalance of Yin and Yang, and disease. Mild insomnia often resolves on its own without the need for medication or interventions, but those with chronic insomnia may seek hospital treatment. Thus, for insomnia treatment, a combined approach of traditional Chinese and Western medicine nursing can be used to address the underlying pathogenesis.

Clinically, to improve patients’ sleep quality and reduce sleep onset time, medications such as anti-anxiety drugs, antidepressants, and sedative-hypnotics are prescribed based on the patient’s main symptoms. Additionally, transcranial magnetic therapy is a method to improve sleep quality. Through electromagnetic induction, transcranial magnetic therapy can stimulate and regulate nerves, creating an electric field response in brain tissue and thereby modulating cortical excitability. For patients with depression and insomnia, who often have heightened cortical arousal, transcranial magnetic therapy can effectively reduce cortical excitability and improve sleep quality ^[4].

According to TCM’s Tibetan image theory, the heart governs the blood vessels and the mind. When the mind is disturbed, symptoms such as restlessness, insomnia, and vivid dreaming may occur. The spleen governs thought; excessive thinking can impair spleen function, leading to blood deficiency and symptoms such as vertigo. The liver plays a crucial role in regulating emotions and aiding spleen and stomach digestion. Emotional disturbances are related to the liver’s dispersing function, where insufficient dispersion leads to depression and sadness, while excessive dispersion can cause headaches. Therefore, regulating the heart, liver, and spleen is key to treating insomnia.

For insomnia, TCM suggests that cupping therapy can warm the meridians, promote blood circulation, dispel wind and cold, and remove toxins. Scraping therapy mobilizes the body’s meridian system, relaxes tendons, clears the meridians, promotes blood circulation, and removes stasis. Regulating blood can balance Yin and Yang, thereby calming the viscera and promoting sleep. Through stimulation of meridians and acupoints, it helps regulate the body’s organs and systems, activating collaterals and promoting restful sleep ^[5]. Key acupoints include Xinshu and Pishu on both sides, Sanyinjiao, Shenmen, and Taibai, with cupping applied on

the Governor Vessel, bladder meridian, and Sanyinjiao on both sides.

The *Huangdi Neijing* (Yellow Emperor's Inner Classic) mentions that "the ear is the sea of meridians," indicating a physiological relationship between the auricle and various body parts. Auricular bean pressing uses the seeds of King's leaves and Cassia seeds to stimulate auricular points, open meridians, regulate blood, and harmonize organs for treatment purposes. For insomnia, acupoints like Shenmen, subcortical, endocrine, kidney, liver, and heart are targeted. Patients press each acupoint 30 times, three times daily, for no more than one minute. Effective pressing induces a sensation of soreness, numbness, or mild pain. The opposite ear is treated the next day, with a seven-day course of treatment. According to meridian flow theory, the body's blood circulates through organs and veins in a daily cycle, linking body functions to specific times. Adhering to this cycle enhances treatment efficacy. For heart-spleen deficiency insomnia, auricular pressing at 10 a.m., noon, and 8 p.m. is particularly effective ^[6].

Clinically, insomnia is often accompanied by vertigo. Alleviating insomnia can reduce vertigo, and better sleep quality can decrease vertigo frequency. One insomnia treatment involves applying a small amount of Wuzhuyu and rice vinegar to the Yongquan points on both feet, promoting blood flow and relieving cold. TCM pillows, filled with ingredients like semen, bamboo leaves, chrysanthemum, and silk, support sleep. A pillow height of 5–10 cm is recommended, as a high pillow can restrict blood flow to the brain, worsening insomnia symptoms and affecting sleep quality ^[7].

From the perspective of TCM meridians, the Zusan Yang and Zusan Yin meridians converge on the foot, connecting with other body meridians. A foot bath can stimulate foot acupoints, improve blood circulation, and indirectly regulate viscera function, promoting sleep. For a TCM foot bath, the formula includes 20 g of corydalis tuber, 10 g each of *Ziziphus jujuba*, *Os Draconis*, *Cyperus rotundus*, and *Albizia julibrissin*, 5 g each of safflower and cinnamon, and 2 g of licorice. The ingredients are soaked for 30 minutes, then decocted in water twice. The resulting 3,000 mL of herbal solution is poured into a foot bath to cover the ankles, with the water temperature maintained at 42–45°C. Patients use the foot bath nightly, rubbing their feet continuously for 20–30 minutes, with a treatment course of two weeks ^[8].

The *Huangdi Neijing* also states that "evil factors" are expelled through sweat, and these factors can be resolved through sweating. TCM fumigation, using hot medicinal steam, opens pores and induces sweating, thereby expelling toxins and regulating blood to alleviate insomnia. The Sleeping decoction for fumigation includes 10 g of *Ziziphus jujuba*, 10 g of *Platycadus orientalis*, 30 g of *Albizia julibrissin*, 30 g of *Polygoni Multiflori Caulis*, 30 g of *Poria* with *Hostwood*, and 10 g of *Polygala tenuifolia*. Additions such as rose and mint address liver stasis, gentian and cape jasmine tackle liver fire, while *Atractylodes Rhizoma*, *Poria cocos*, and *Aucklandia lappa* Decne benefit spleen deficiency. If the heart and kidney are unbalanced, *Coptidis Rhizoma* and cinnamon are included ^[9].

5. Conclusion

The purpose of this paper is to explore the causes of insomnia in young and middle-aged people and the effects of integrated traditional Chinese and Western medicine nursing interventions for insomnia patients. The specific conclusions are as follows:

- (1) Based on the investigation results, it was concluded that insomnia caused by work or life pressure (emotional or economic problems) accounted for the largest proportion of cases. Among the patients,

those whose insomnia improved after integrated traditional Chinese and Western medicine interventions also accounted for the largest proportion.

- (2) Transcranial magnetic stimulation is a safe and non-invasive physiotherapy method that can effectively relieve sleep disorders and improve sleep quality ^[10].
- (3) Sedatives, hypnotics, antidepressants, and other drugs are commonly used in the treatment of insomnia in Western medicine. Although these medications can temporarily relieve symptoms, they cannot provide a permanent cure, and long-term use often leads to adverse reactions. Patients may develop drug dependence and may even refuse to take the medication due to psychological concerns, making the effect of a radical cure less ideal. During treatment, the dosage of Western medicine can be gradually reduced to avoid side effects, while also compensating for the slow onset of traditional Chinese medicine ^[11,12].
- (4) From the perspective of traditional Chinese medicine, excessive worry, accumulation, and depression can deplete the organs of blood, Yin, and Yang, leading to a loss of inner peace and disturbance by external factors, which ultimately results in insomnia ^[13]. Therefore, it is necessary to strengthen psychological nursing, effectively soothe patients, and guide them to release negative emotions in appropriate ways. This approach helps restore psychological balance, regulates blood flow, protects the spirit internally, and improves sleep quality.

Funding

2024 China Mainland-Hong Kong-Macao University Teachers and Students Exchange Program (Project No. 202311060001)

Disclosure statement

The authors declare no conflict of interest.

References

- [1] Chinese Society of Neurology, Chinese Society of Sleep Disorders, 2018, Chinese Guidelines for the Diagnosis and Treatment of Insomnia in Adults (2017 Edition). Chinese Journal of Neurology, 51(5): 324–335.
- [2] Zhang J, 2011, Jing Yue Quanshu (Jing Yue's Complete Works). China Medical Science and Technology Press, Beijing.
- [3] Wei C, Fu X, 2017, Effects of Psychological Nursing Intervention on Sleep Quality of Neurosis Patients with Insomnia. Modern Medicine and Health, 33(7): 1083–1085.
- [4] Luo T, Huang J, Lin Y, 2022, Clinical Value of Transcranial Magnetic Therapy Instrument Combined with A Comprehensive Nursing Model in Patients with Depression and Insomnia. Medical Equipment, 35(2): 113–115.
- [5] Qu T, Zhang D, 2020, Clinical Nursing Evaluation of Scraping Combined with Cupping Therapy for Insomnia. Modern Distance Education of Chinese Traditional Medicine, 18(11): 93–94 + 123.
- [6] Lu Y, Hou W, Wang X, et al., 2020, Nursing Research on the Treatment of Insomnia Due to Deficiency of Heart and Spleen with Meridian Flowing and Auricular Point Sticking. Smart Healthcare, 6(11): 184–185 + 188.
- [7] Zhang H, Liu R, 2021, Application of Traditional Chinese Medicine Nursing in Patients with Vertigo and Insomnia.

Medical Food Therapy and Health, 19(3): 131–132.

- [8] Wang Y, Yang Y, 2021, Clinical Efficacy of Traditional Chinese Medicine Foot Bath Combined with Auricular Point Pressing in the Treatment of Insomnia. Medical Equipment, 34(7): 124–125.
- [9] Chen Y, 2020, The Therapeutic Effect of Traditional Chinese Medicine Fumigation on 36 Cases of Insomnia. Forum of Primary Medical Science, 24(32): 4696–4697.
- [10] Wu Y, Wu J, Wu L, 2020, Application Effect of Individualized Nursing Combined with Transcranial Magnetic Stimulation Therapeutic Apparatus in Patients with Depression and Sleep Disorders. Medical Equipment, 33(7): 135–137.
- [11] Zhao S, 2017, Clinical Effect Analysis of Traditional Chinese Medicine Nursing on Patients with Insomnia. Chinese Journal of Applied Neurology, 20(6): 132–134.
- [12] Jin Y, 2021, Research Progress of Traditional Chinese and Western Medicine in the Treatment of Chronic Insomnia. Popular Science and Technology, 23(2): 61–63 + 66.
- [13] Liang S, Lin Y, Ju L, 2020, Research Progress of Traditional Chinese Medicine Nursing Technology in the Treatment of Depression with Insomnia. Nursing of Integrated Traditional Chinese and Western Medicine, 6(10): 155–156.

Publisher's note

Bio-Byword Scientific Publishing remains neutral with regard to jurisdictional claims in published maps and institutional affiliations.

Application of a Chest Compression Device Combined with Extended Self-Care for Scar Prevention in Patients After Keloid Excision Surgery

Min Shen, Miao Chen*

Department of Plastic and Reconstructive Surgery, First Medical Center of PLA General Hospital, Beijing 100853, China

*Corresponding author: Miao Chen, 13501230220@163.com

Copyright: © 2024 Author(s). This is an open-access article distributed under the terms of the Creative Commons Attribution License (CC BY 4.0), permitting distribution and reproduction in any medium, provided the original work is cited.

Abstract: *Objective:* To explore the effectiveness of a chest compression device combined with extended self-care for scar prevention in patients following keloid excision surgery. *Methods:* Forty patients (36 lesions) who underwent keloid excision surgery at the Department of Plastic and Reconstructive Surgery, First Medical Center, PLA General Hospital from June 2022 to June 2024 were selected. They were randomly divided into an experimental group and a control group, with 20 patients in each group. The control group received traditional elastic garment compression therapy, while the experimental group used a chest compression device designed for scar prevention. Scar width, hypertrophy, and Vancouver Scar Scale (VSS) scores were compared between the two groups at 6 months post-operation. *Results:* There were no statistically significant differences between the two groups in terms of gender, age, disease duration, lesion area, or location ($P > 0.05$). However, VSS scores (except for pliability) in the experimental group were significantly lower than those in the control group ($P < 0.05$). *Conclusion:* The chest compression device for scar prevention is more effective than traditional elastic garments in preventing scar hypertrophy after chest wall keloid excision surgery, and it has high clinical value, making it worthy of promotion.

Keywords: Scar prevention; Compression device; Scar hypertrophy

Online publication: November 27, 2024

1. Introduction

Keloids are benign skin tumors that result from excessive growth and deposition of extracellular matrix during skin healing, leading to abnormal outcomes. The hallmark characteristic of keloids is local fibrous tissue overgrowth, which manifests as raised red or purplish nodules on the skin surface, often accompanied by itching

and pain ^[1,2]. Keloids can negatively affect a patient's appearance and may cause functional impairment, greatly impacting their quality of life. Surgical excision is the primary treatment for keloids, but the recurrence rate is extremely high, ranging from 45% to 100% ^[3,4]. The formation and progression of keloids are closely related to local tension, with higher tension increasing the likelihood of keloid development ^[5]. Elastic compression, a simple, safe, and low-cost physical therapy method, is widely used for the prevention and treatment of keloids. It works by applying continuous pressure to the scar surface, reducing local blood supply, inhibiting fibroblast proliferation, and collagen synthesis, thereby preventing scar hypertrophy and promoting scar maturation ^[6].

Currently, the most commonly used compression therapy in clinical practice is the wearing of elastic garments. However, traditional elastic garments have several limitations, such as:

- (1) Uneven pressure distribution: It is difficult to precisely control the pressure distribution of elastic garments, particularly for irregularly shaped areas like the chest, leading to excessive or insufficient local pressure.
- (2) Inability to adjust pressure: As the patient's chest dimensions and wound healing progress over time, adjustments to the pressure and position of the elastic garment are needed, which traditional garments cannot accommodate.
- (3) Discomfort: Traditional elastic garments are made of thick materials with poor breathability, and long-term wear can lead to local skin moisture and itching, reducing patient comfort and compliance.

To address these limitations, novel chest compression devices designed for scar prevention have emerged in recent years. This study aims to investigate the effectiveness of these devices in patients after keloid excision surgery and to compare them with traditional elastic garments, providing a more effective scar prevention treatment for clinical practice.

2. Materials and methods

2.1. General information

Forty patients who underwent keloid excision surgery at the Department of Plastic and Reconstructive Surgery, First Medical Center, PLA General Hospital between June 2022 and June 2024 were selected, with a total of 36 lesions. Inclusion criteria: (1) diagnosed with keloid, meeting the diagnostic criteria for keloid; (2) clear consciousness and able to cooperate with treatment; (3) local patients who can easily return to the hospital for follow-up. Exclusion criteria: (1) patients with severe heart, brain, liver, kidney diseases, or diabetes; (2) patients unwilling to cooperate or with unstable mental status unable to cooperate with treatment.

2.2. Methods

The 40 patients meeting the inclusion criteria were randomly divided into an experimental group and a control group, with 20 patients in each group. Both groups received preoperative health education, including the formation of keloids, surgical treatment, postoperative care, and dietary guidance.

Control group: After planned drainage tube removal (3–7 days post-operation), patients began wearing medical elastic garments for compression therapy, with a daily wear time of no less than 20 hours for 6 months.

Experimental group: Patients used a chest compression device designed for scar prevention (see **Figure 1**).

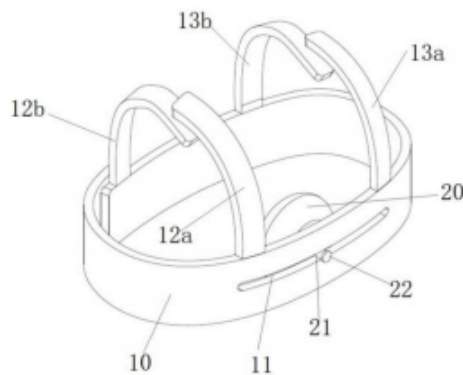


Figure 1. Chest compression device for scar prevention

The establishment of extended self-care via the Douyin platform (a popular social media platform) aimed to enhance communication and connection between healthcare professionals and patients, improving patients' care experience and satisfaction. Regular disease-related health education content was posted, such as prevention knowledge, treatment progress, and rehabilitation techniques, to improve patients' health literacy.

2.3. Observation indicators

2.3.1. Treatment effect

The treatment effects of the two groups were analyzed and compared as follows:

Effectiveness rate: Treatment effects were categorized into three types. "Good effect" refers to the complete disappearance of itching and pain symptoms, with flat scars and no recurrence within six months. "Marked effect" refers to the partial disappearance of itching and pain symptoms, with mild scar hypertrophy and scar thickness reduced by 70% to 80% as measured by 3D morphometric software^[7]. "Ineffective" refers to no reduction or alleviation of itching and pain symptoms, with significant hypertrophy and no notable change in scar thickness. The effectiveness rate was calculated as (number of good effect cases + number of marked effect cases) / total number of cases × 100%.

2.3.2. Vancouver Scar Scale

Vancouver Scar Scale (VSS) includes four evaluation indicators^[8]:

- (1) Pigmentation assessment: skin color similar to the surrounding normal skin is scored as 0 points, lighter pigmentation as 1 point, mixed pigmentation as 2 points, and darker pigmentation as 3 points.
- (2) Vascularity assessment: normal skin tone similar to other parts of the body is scored as 0 points, pink tone as 1 point, red tone as 2 points, and purple tone as 3 points.
- (3) Thickness assessment: normal thickness is scored as 0 points, 0 to 1 mm as 1 point, 1 to 2 mm as 2 points, 2 to 4 mm as 3 points, and greater than 4 mm as 4 points.
- (4) Pliability assessment: normal is scored as 0 points, soft as 1 point, yielding as 2 points, firm as 3 points, banding as 4 points, and contracture as 5 points. The highest possible score on this scale is 15 points, and the lowest is 0 points. The higher the score, the more severe the scar hypertrophy.

2.4. Statistical analysis

Data analysis was performed using SPSS 23.0 statistical software. Measurement data were expressed as mean \pm standard deviation (SD), and comparisons between groups were made using the *t*-test. Count data were expressed as [*n* (%)], and comparisons between groups were made using the χ^2 test. A *P*-value of < 0.05 was considered statistically significant.

3. Results

3.1. Comparison of baseline data between the two groups

There were no statistically significant differences between the two groups in terms of gender, age, disease duration, lesion area, or lesion site ($P > 0.05$), indicating comparability (**Table 1**).

Table 1. Comparison of baseline data between the two groups

Group	Number of cases (<i>n</i>)	Gender (<i>n</i>)		Age (mean \pm SD, years)	Average disease duration (mean \pm SD, months)	Lesion area (mean \pm SD, cm ²)
		Male	Female			
Control	20	10	10	35.15 \pm 5.52	6.60 \pm 2.37	7.31 \pm 4.11
Experimental	20	12	8	34.63 \pm 6.71	6.81 \pm 2.43	8.40 \pm 3.74
χ^2/t -value		0.404		0.268	0.277	0.877
<i>P</i> -value		0.525		0.790	0.784	0.386

3.2. Postoperative treatment effect in the two groups

The total effectiveness rate in the experimental group was 95.00%, significantly higher than 60.00% in the control group ($\chi^2 = 5.161$, $P = 0.023$), which is statistically significant (see **Table 2**).

Table 2. Postoperative treatment effect in the two groups [*n* (%)]

Group	<i>n</i>	Good effect	Marked effect	Ineffective	Total effective rate
Control	20	9 (45.00%)	3 (15.00%)	8 (35.00%)	12 (60.00%)
Experimental	20	17 (85.00%)	2 (10.00%)	1 (5.00%)	19 (95.00%)
χ^2 -value	-	-	-	-	5.161
<i>P</i> -value	-	-	-	-	0.023

3.3. Comparison of postoperative VSS scores between the two groups

In the experimental group, the VSS scores for pigmentation, vascularity, thickness, and total score were significantly lower than those in the control group (all $P < 0.05$), with notable differences. However, there was no statistically significant difference in pliability ($P = 0.130$) (see **Table 3**).

Table 3. Comparison of postoperative VSS scores between the two groups (mean \pm SD, points)

Group	Vancouver Scar Scale (VSS)				
	Pigmentation	Vascularity	Thickness	Pliability	Total score
Control	1.71 \pm 0.93	1.48 \pm 0.79	2.48 \pm 1.07	1.67 \pm 0.96	7.34 \pm 2.34
Experimental	1.10 \pm 0.57	0.77 \pm 0.53	1.45 \pm 0.80	1.25 \pm 0.74	4.57 \pm 1.80
<i>t</i> -value	2.501	3.338	3.448	1.550	4.196
<i>P</i> -value	0.017	0.002	0.001	0.130	< 0.001

4. Discussion

Keloids are an abnormal repair outcome following skin damage, characterized by the excessive accumulation of extracellular matrix components, particularly collagen, and the abnormal proliferation of fibroblasts, eventually forming hard, raised scar tissue on the surface of the skin. Due to the unique anatomical structure and functional characteristics of the chest skin, it is one of the high-risk areas for keloid formation. Various types of skin damage, even minor scratches or acne, can result in noticeable scars on the chest, often accompanied by itching and pain ^[9]. Keloids that cross the midline of the chest are particularly prone to hypertrophy and recurrence due to the tension exerted by the skin on both sides. Some studies suggest that tension can promote fibroblast proliferation and collagen synthesis, inhibit apoptosis, and induce angiogenesis, thereby encouraging the formation and growth of pathological scars ^[10]. Therefore, clinical practice often employs tension-reducing measures to decrease tension in chest skin, inhibiting scar hypertrophy and preventing keloid recurrence ^[11]. For example, using preventive chest compression devices can apply continuous, even pressure to the chest area, effectively distributing skin tension. Compared to traditional compression garments, new compression devices can more precisely control pressure distribution, allowing for personalized adjustments in areas like the chest and scapula, ensuring treatment effectiveness while minimizing the impact on daily activities, thus improving the patient's quality of life and holding great clinical potential.

The results of this study show that, compared to traditional compression garments, preventive chest compression devices are more effective in preventing scar hypertrophy after keloid excision surgery on the chest wall. This may be attributed to the following factors:

- (1) More even pressure distribution: The preventive chest compression device adopts an ergonomic design, allowing for personalized customization to ensure sustained, even pressure distribution over the scar area.
- (2) Better breathability: Made from breathable materials such as mesh fabric, it keeps the scar dry and reduces the risk of infection.
- (3) More comfortable to wear: The device is designed with comfort in mind, using lightweight, soft materials and adjustable straps to enhance the wearer's comfort, ensuring treatment efficacy.
- (4) Easier movement: The flexible design reduces restrictions on the patient's movement, making it easier to engage in daily activities and work, thereby improving quality of life.
- (5) Precise pressure control: The built-in pressure sensor enables real-time monitoring and adjustment of pressure, ensuring the scar area is always under optimal pressure, thus improving overall treatment outcomes.

5. Conclusion

In conclusion, the preventive chest compression device is more effective than traditional compression garments in preventing scar hypertrophy after chest keloid excision surgery. It offers advantages such as comfort, ease of movement, and precise pressure control, making it highly valuable for clinical application and worthy of widespread promotion.

Disclosure statement

The authors declare no conflict of interest.

References

- [1] Bi S, Liu R, Wu B, et al., 2021, Bioinformatic Analysis of Key Genes and Pathways Related to Keloids. *Biomed Res Int*, 2021: 5897907. <https://doi.org/10.1155/2021/5897907>
- [2] Stone RC, Chen V, Burgess J, et al., 2020, Genomics of Human Fibrotic Diseases: Disordered Wound Healing Response. *Int J Mol Sci*, 21(22): 8590. <https://doi.org/10.3390/ijms21228590>
- [3] Renz P, Hasan S, Gresswell S, et al., 2018, Dose Effect in Adjuvant Radiation Therapy for the Treatment of Resected Keloids. *Int J Radiat Oncol Biol Phys*, 102(1): 149–154. <https://doi.org/10.1016/j.ijrobp.2018.05.027>
- [4] Long X, Zhang M, Wang Y, et al., 2016, Algorithm of Chest Wall Keloid Treatment. *Medicine (Baltimore)*, 95(35): e4684. <https://doi.org/10.1097/MD.00000000000004684>
- [5] Hao YH, Xing XJ, Zhao ZG, et al., 2019, A Multimodal Therapeutic Approach Improves the Clinical Outcome of Auricular Keloid Patients. *Int J Dermatol*, 58(6): 745–749. <https://doi.org/10.1111/ijd.14413>
- [6] Ogawa R, Akaishi S, Huang C, et al., 2011, Clinical Applications of Basic Research That Shows Reducing Skin Tension Could Prevent and Treat Abnormal Scarring: The Importance of Fascial/Subcutaneous Tensile Reduction Sutures and Flap Surgery for Keloid and Hypertrophic Scar Reconstruction. *J Nippon Med Sch*, 78(2): 68–76. <https://doi.org/10.1272/jnms.78.68>
- [7] Bai C, 2013, Observation on the Efficacy of Epidermal Surgery Combined with 90Sr Patch Radiotherapy in the Treatment of Chest Keloids. *Chinese Journal of Integrated Traditional and Western Medicine in Dermatology and Venereology*, 12(6): 384–385.
- [8] Bao W, 2000, *Practical Scar Science*. Beijing Medical University Press, Beijing, 74–77.
- [9] Kelly AP, 2009, Update on the Management of Keloids. *Semin Cutan Med Surg*, 28(2): 71–76. <https://doi.org/10.1016/j.sder.2009.04.002>
- [10] Wang L, Wang H, Xin B, et al., 2011, Clinical Analysis of 50 Cases of Comprehensive Treatment of Trunk Keloids. *Chinese Journal of Aesthetic Medicine*, 20(6): 901–903.
- [11] Park TH, Seo SW, Kim JK, et al., 2011, Management of Chest Keloids. *J Cardiothorac Surg*, 6: 49. <https://doi.org/10.1186/1749-8090-6-49>

Publisher's note

Bio-Byword Scientific Publishing remains neutral with regard to jurisdictional claims in published maps and institutional affiliations.

Satisfaction in Birth Experience among Women with Doula Delivery Support: A Correlational-Comparative Study

Jingwen Wang*, Ma. Theresa Salinda

Institute of Health Sciences and Nursing, Far Eastern University, Manila, Metro Manila 1015, Philippines

*Corresponding author: Jingwen Wang, 24wangjingwen@gmail.com

Copyright: © 2024 Author(s). This is an open-access article distributed under the terms of the Creative Commons Attribution License (CC BY 4.0), permitting distribution and reproduction in any medium, provided the original work is cited.

Abstract: *Objective:* This study aimed to evaluate the effectiveness and benefits of doula services by comparing satisfaction with the childbirth experience between women who received doula support and those who did not. *Methods:* A correlational comparative research design with a quantitative approach was utilized. Purposive sampling was used to gather participants. The collected data were analyzed using MS Excel and the Statistical Package for Social Sciences (SPSS). Statistical methods included the Mean, Pearson correlation, and Wilcoxon test. In this study, an online survey questionnaire was disseminated in Shijiazhuang City, Hebei Province. *Results:* Findings showed that expectant mothers who received doula support reported high satisfaction across various domains, whereas those without doula support had lower satisfaction during childbirth. *Conclusion:* The results suggest that doula support is important for expectant mothers, as it helps to reduce stress and anxiety during labor and delivery. Integrating doula support into maternity care can enhance the childbirth experience, leading to higher satisfaction and improved outcomes.

Keywords: Doula support; Non-doula; Emotional support; Physical comfort; Satisfaction; Positive effects

Online publication: November 27, 2024

1. Introduction

The World Health Organization (WHO) emphasizes the importance of supportive and respectful care during childbirth, advocating for access to high-quality care for all women ^[1]. Despite this, maternal mortality rates remain high globally, with around 295,000 maternal deaths reported in 2017 ^[2]. The leading causes of maternal mortality include severe postpartum bleeding, post-delivery infections, delivery complications, and hypertensive disorders in pregnancy, such as preeclampsia and eclampsia. Many of these fatalities could be prevented with appropriate support and care during childbirth.

Research by Bohren *et al.* ^[3] suggests that continuous support during labor can lead to more satisfying birth experiences and better outcomes for both mother and child. A 2017 Cochrane review of 26 studies involving

15,858 women found that continuous labor support increased the likelihood of spontaneous vaginal birth, reduced the need for pain relief, and decreased the risk of adverse outcomes.

Providing comprehensive maternal care during childbirth is crucial. The full-process doula-accompanied midwifery model, where professional doulas assist women throughout the entire delivery process, is a humane approach that meets the need for comprehensive care ^[4]. This model offers comfort and reassurance by providing continuous companionship, updates on delivery progress, and encouragement, thereby helping mothers maintain the confidence and motivation needed for childbirth. This study aims to demonstrate that full-time doula support can shorten labor duration and improve obstetric care quality.

Childbirth is a natural process, but as medical practices evolve and the concept of humanized services becomes integral to obstetrics, modern obstetric research increasingly focuses on how to enhance maternal outcomes and minimize delivery-related discomfort and complications ^[5]. Doula support offers a compassionate delivery approach, providing physical and psychological assistance to mothers. Research on guided delivery analgesia for first-time mothers has shown positive effects on labor duration, postpartum hemorrhage, and neonatal asphyxia, helping to reduce pain, increase pain tolerance, and lower cesarean delivery rates ^[6].

Guided labor support relies on experienced individuals who provide emotional, spiritual, and physical assistance to mothers, supporting them through successful deliveries. With the increasing trend of later-age childbirth in China, cesarean delivery rates have risen, posing added physical risks for mothers ^[7]. Guided labor analgesia can help alleviate maternal fears and reduce pain during natural childbirth. Partnering with a doula can maximize maternal relaxation, fostering a cooperative dynamic that enhances the birthing experience.

Thus, this study aims to explore the correlation between maternal profiles, satisfaction levels, and the delivery experience among mothers receiving doula-supported care. Additionally, this research seeks to contribute to quality improvement in obstetric care, promoting strategic childbirth experiences that empower mothers during labor and facilitate shared decision-making in the delivery process.

2. Methods

The research design used in this study is a correlational comparative approach with a quantitative methodology. Purposive sampling was employed to gather participants, including 60 postpartum women: 30 who chose doula support and 30 who did not. The data collected from these participants were then analyzed separately to assess the level of support.

2.1. Doula provider

Doulas can provide women with practical and emotional support during the pre-partum, mid-partum, and postpartum periods. They help mothers build confidence in childbirth, reduce childbirth-related fears and anxiety, relieve pain during labor, and guide and facilitate the delivery process. To be qualified, doulas must meet the following standards: (1) complete relevant training and assessment from the China Maternal and Child Health Association and obtain a professional qualification certificate, and (2) possess relevant experience in fields like gynecology and pediatrics, along with familiarity with gynecological, obstetric, and pediatric knowledge. Doulas should also demonstrate dedication and substantial experience in midwifery.

2.2. Non-doula provider

Childbirth is a critical life event for women, requiring substantial physical and emotional support. While doulas are known to provide continuous, personalized support, many women experience childbirth without the assistance of a doula. These non-doula-supported women may face various challenges that negatively impact their childbirth experience. Understanding the specific challenges faced by non-doula-supported women is essential for improving maternal care and ensuring positive childbirth experiences for all.

2.3. Population and sampling

Purposive sampling was used to gather participants. This non-probability technique does not require a theoretical basis or a specific number of participants. By using this sampling method, the researcher was able to identify specific knowledge gaps and select individuals who were both able and willing to provide information based on their experiences^[8]. Hospital staff were informed of the criteria for qualified respondents, and the hospital assisted in identifying eligible participants through patient records. The final list of respondents was chosen by the researcher.

Participants included those admitted to the hospital during the interview period. Selection criteria were: (1) expectant mothers aged 18–40 years, (2) Chinese citizens, and (3) gestational age between 36–42 weeks.

2.4. Research instruments

A self-designed questionnaire was used to collect data. This questionnaire covered demographic details such as the respondent's age, parity (number of previous pregnancies), marital status, delivery setting, gestational age, and previous experience with doulas. It aimed to determine correlations between doula support and the childbirth experience among expectant mothers. The questionnaire consisted of four sections: Expectant Mothers' Satisfaction with Doula Delivery Support; Impact of Doula Presence on Labor Duration; Specific Aspects of Doula Support in Reducing Maternal Anxiety and Fear during Childbirth; and Influence of Doula Support on Expectant Mothers' Perception of Pain during Labor and Delivery. Four experts and a psychometrician validated the questions.

2.5. Statistical treatment

Upon obtaining all necessary data, the researcher organized and statistically processed the information. MS Excel and the Statistical Package for Social Sciences (SPSS) were used to analyze the data. Statistical tools were applied for tabulation and further data analysis.

The participants were given questionnaires and asked to provide consent for participation in the study. The study was conducted during the 2023–2024 academic year and disseminated via online platforms. The participants were selected based on data saturation.

This study included 30 expectant mothers who chose doula support from a sample of 32, and 30 expectant mothers who did not choose doula support (**Table 1**). The sample size of 30 was determined from a population size of 1,000, with a margin of error of 5%, a confidence level of 95%, and a response distribution of 50%, using the Raosoft online sample size calculator.

Table 1. Participants of the study

Sample size	Expectant mother	Total
With doula support	32	30
Non-doula support	32	30

3. Level of satisfaction with doula delivery support during childbirth

3.1. Emotional support

Table 2 shows the satisfaction of doula delivery support in terms of emotional support.

Table 2. Satisfaction on doula delivery support: emotional support

Emotional support	Mean	SD	Qualitative description
The doula provided emotional comfort and reassurance during labor and delivery.	3.73	0.45	High level
I felt emotionally supported and cared for by the doula throughout the childbirth process.	3.70	0.47	High level
The doula's presence helped me feel more at ease and less anxious during labor.	3.67	0.48	High level
I believe that the emotional support provided by the doula positively influenced my childbirth experience.	3.70	0.47	High level
Category mean	3.70	0.47	High level

Table 2 provides an assessment of satisfaction with doula delivery support specifically in the domain of emotional support, measured through various indicators. The highest-ranked indicator is “The doula provided emotional comfort and reassurance during labor and delivery,” with a mean score of 3.73 and a standard deviation of 0.45, interpreted as a high level of satisfaction. Two indicators share the second rank: “I felt emotionally supported and cared for by the doula throughout the childbirth process” and “I believe that the emotional support provided by the doula positively influenced my childbirth experience,” both with a mean score of 3.70 and a standard deviation of 0.47, also interpreted as a high level of satisfaction. The fourth-ranked indicator is “The doula's presence helped me feel more at ease and less anxious during labor,” which has a mean score of 3.67 and a standard deviation of 0.48, maintaining a high level of satisfaction.

Overall, the composite score for emotional support is 3.70 with a standard deviation of 0.47, indicating a high level of satisfaction with the emotional support provided by doulas during delivery. This consistently high level of satisfaction across all indicators underscores the significant positive impact of doula support on the emotional well-being of mothers during childbirth.

This finding supports Sobczak *et al.* ^[9], who stated that support during birth promotes positive outcomes for both the mother and baby. The doula program is essential throughout pregnancy. Continuous support also increases positive feelings about the labor experience, and several studies have found a correlation between continuous support and a positive maternal outlook ^[10].

3.2. Physical support

Table 3 shows the satisfaction of doula delivery support in terms of physical support.

Table 3. Satisfaction on doula delivery support: physical support

Physical support	Mean	SD	Qualitative interpretation
The doula provided helpful physical comfort measures and pain relief techniques during labor.	3.44	0.51	High level
I felt more comfortable and supported physically with the doula's assistance during childbirth.	3.48	0.50	High level
The doula's physical support contributed to a more positive birthing experience for me.	3.45	0.50	High level
I believe that the doula's physical support helped me cope better with the challenges of labor.	3.46	0.51	High level
Category mean	3.47	0.51	High level

Table 3 assesses satisfaction with doula delivery support in the area of physical support, based on various indicators. The highest-ranked indicator is "I felt more comfortable and supported physically with the doula's assistance during childbirth," with a mean score of 3.48 and a standard deviation of 0.50, interpreted as a high level of satisfaction. The indicator with the lowest mean is "The doula provided helpful physical comfort measures and pain relief techniques during labor," with a mean score of 3.44, still indicating a high level of satisfaction.

Overall, the composite score for physical support is 3.47 with a standard deviation of 0.51, denoting a high level of satisfaction with the physical support provided by doulas during labor and delivery. This consistently high satisfaction across all indicators highlights the significant positive impact of doula physical support on the birthing experience.

This supports the study by Rousseau *et al.* ^[11], which stated that physical support is a crucial part of a holistic definition of health and a consistent predictor of positive outcomes. Physical support from doulas reduces anxiety and morbidities and establishes a support system, enabling mothers to have a safety net. This suggests that doulas play an important role before and during delivery ^[12].

3.3. Communication

Table 4 shows the satisfaction of doula delivery support in terms of communication.

Table 4. Satisfaction on doula delivery support: communication

Communication	Mean	SD	Qualitative interpretation
The doula effectively communicated with me and understood my preferences and needs during labor.	3.40	0.50	High level
I felt heard and respected in my decision-making process with the doula's guidance.	3.50	0.51	High level
The doula helped facilitate communication with healthcare providers and advocated for my preferences.	3.43	0.50	High level
I believe that the communication between the doula and the healthcare team positively impacted my birth experience.	3.40	0.50	High level
Category mean	3.43	0.50	High level

Table 4 evaluates satisfaction with doula delivery support in terms of communication, using various indicators. The highest-ranked indicator is “I felt heard and respected in my decision-making process with the doula’s guidance,” with a mean score of 3.50 and a standard deviation of 0.51, interpreted as a high level of satisfaction. Two indicators are ranked last: “The doula effectively communicated with me and understood my preferences and needs during labor” and “I believe that the communication between the doula and healthcare team positively impacted my birth experience,” both with a mean score of 3.40 and a standard deviation of 0.50, reflecting a high level of satisfaction.

Overall, the composite score for communication is 3.43 with a standard deviation of 0.50, denoting a high level of satisfaction with the communication support provided by doulas during labor and delivery. This consistently high satisfaction across all indicators underscores the significant positive impact of effective communication by doulas on the childbirth experience.

This is supported by Roth *et al.* ^[13], who found that communication between healthcare teams and doulas impacts outcomes. Nurses who have worked with doulas and value labor support report more positive outcomes. Lucas and Wright ^[14] identified studies showing that healthcare teams can lead to greater openness, creating approaches that contribute to positive outcomes, and enhancing the communication system.

3.4. Empowerment

Table 5 shows the satisfaction of doula delivery support in terms of empowerment.

Table 5. Satisfaction on doula delivery support: empowerment

Empowerment	Mean	SD	Qualitative interpretation
The doula’s presence and support empowered me to make informed decisions during childbirth.	3.43	0.50	High level
I felt more confident and in control with the doula’s assistance during labor and delivery.	3.47	0.51	High level
The doula’s advocacy for my choices and preferences made me feel empowered during childbirth.	3.47	0.51	High level
I believe that the doula’s support played a significant role in enhancing my sense of empowerment during childbirth.	3.43	0.50	High level
Category mean	3.43	0.50	High level

Table 5 assesses satisfaction with doula delivery support in terms of empowerment, based on various indicators. The highest-ranked indicator is “I felt more confident and in control with the doula’s assistance during labor and delivery,” with a mean score of 3.47 and a standard deviation of 0.51, interpreted as a high level of satisfaction. Closely following is “The doula’s advocacy for my choices and preferences made me feel empowered during childbirth,” also with a mean score of 3.47 and a standard deviation of 0.51, reflecting a high level of satisfaction.

Two indicators share the lowest mean: “The doula’s presence and support empowered me to make informed decisions during childbirth” and “I believe that the doula’s support played a significant role in enhancing my sense of empowerment during childbirth,” both with a mean score of 3.43 and a standard deviation of 0.50, indicating a high level of satisfaction.

Overall, the composite score for empowerment is 3.43 with a standard deviation of 0.50, denoting a high

level of satisfaction with the empowerment provided by doulas during labor and delivery. This consistently high satisfaction across all indicators highlights the significant positive impact of doula support on enhancing mothers' sense of empowerment during childbirth.

This finding aligns with Gomez *et al.* ^[15], who emphasize the importance of creating opportunities that empower mothers and healthcare teams. This empowerment fosters hope, dismantles barriers, and strengthens partnerships. Additionally, promoting empowerment helps advance quality in maternal care, ensuring fair and equitable treatment for mothers throughout pregnancy and childbirth.

4. Conclusion

Based on the findings, doula support is essential for expectant mothers. It helps reduce stress and anxiety during labor and delivery. Furthermore, integrating doula support into maternity care can greatly enhance the childbirth experience, leading to higher satisfaction and improved outcomes for mothers.

Disclosure statement

The authors declare no conflict of interest.

References

- [1] World Health Organization (WHO), 2018, Recommendations: Intrapartum Care for A Positive Childbirth Experience, viewed October 7, 2024, <https://iris.who.int/bitstream/handle/10665/260178/9789241550215-eng.pdf>
- [2] UNFPA, World Health Organization, UNICEF, et al., 2019, Trends in Maternal Mortality 2000 to 2017: Estimates by WHO, UNICEF, UNFPA, World Bank Group and the United Nations Population Division, viewed October 7, 2024, https://www.unfpa.org/sites/default/files/pub-pdf/Maternal_mortality_report.pdf
- [3] Bohren MA, Hofmeyr GJ, Sakala C, et al., 2017, Continuous Support for Women During Childbirth. *Cochrane Database Syst Rev*, 7(7): CD003766. <https://doi.org/10.1002/14651858.CD003766.pub6>
- [4] Felder JN, Lemon E, Shea K, et al., 2016, Role of Self-Compassion In Psychological Well-Being Among Perinatal Women. *Arch Womens Ment Health*, 19(4): 687–690. <https://doi.org/10.1007/s00737-016-0628-2>
- [5] Sng BL, Sia ATH, 2017, Maintenance of Epidural Labour Analgesia: The Old, The New and The Future. *Best Pract Res Clin Anaesthesiol*, 31(1): 15–22. <https://doi.org/10.1016/j.bpa.2017.01.002>
- [6] Du W, Bo L, Xu Z, et al., 2022, Childbirth Pain, Labor Epidural Analgesia, and Postpartum Depression: Recent Evidence and Future Directions. *J Pain Res*, 15: 3007–3015. <https://doi.org/10.2147/JPR.S379580>
- [7] Long Q, Zhang Y, Zhang J, et al., 2022, Changes in Caesarean Section Rates in China During the Period of Transition from The One-Child to Two-Child Policy Era: Cross-Sectional National Household Health Services Surveys. *BMJ Open*, 12(4): e059208. <https://doi.org/10.1136/bmjopen-2021-059208>
- [8] Campbell S, Greenwood M, Prior S, et al., 2020, Purposive Sampling: Complex or Simple? Research Case Examples. *J Res Nurs*, 25(8): 652–661. <https://doi.org/10.1177/1744987120927206>
- [9] Sobczak A, Taylor L, Solomon S, et al., 2023, The Effect of Doulas on Maternal and Birth Outcomes: A Scoping Review. *Cureus*, 15(5): e39451. <https://doi.org/10.7759/cureus.39451>
- [10] Safarzadeh A, Shafipour V, Salar A, 2018, Expectant Mothers' Experiences with Lay Doulas in Maternity Units of Hospitals in Impoverished Areas of Iran: A Qualitative Study. *Iran J Nurs Midwifery Res*, 23(6): 437–443. <https://doi.org/10.21860/ijnm.2018.23.6.437>

org/10.4103/ijnmr.IJNMR_109_17

- [11] Rousseau S, Katz D, Shlomi-Polachek I, et al., 2021, Prospective Risk from Prenatal Anxiety to Post Traumatic Stress Following Childbirth: The Mediating Effects of Acute Stress Assessed During the Postnatal Hospital Stay and Preliminary Evidence for Moderating Effects of Doula Care. *Midwifery*, 103: 103143. <https://doi.org/10.1016/j.midw.2021.103143>
- [12] McLeish J, Redshaw M, 2018, A Qualitative Study of Volunteer Doulas Working Alongside Midwives at Births in England: Mothers' and Doulas' Experiences. *Midwifery*, 56: 53–60. <https://doi.org/10.1016/j.midw.2017.10.002>
- [13] Roth LM, Henley MM, Seacrist MJ, et al., 2016, North American Nurses' and Doulas' Views of Each Other. *J Obstet Gynecol Neonatal Nurs*, 45(6): 790–800. <https://doi.org/10.1016/j.jogn.2016.06.011>
- [14] Lucas L, Wright E, 2019, Attitudes of Physicians, Midwives, and Nurses About Doulas: A Scoping Review. *MCN Am J Matern Child Nurs*, 44(1): 33–39. <https://doi.org/10.1097/NMC.0000000000000488>
- [15] Gomez AM, Arteaga S, Arcara J, et al., 2021, “My 9 to 5 Job Is Birth Work”: A Case Study of Two Compensation Approaches for Community Doula Care. *International Journal of Environmental Research and Public Health*, 18(20): 10817. <https://doi.org/10.3390/ijerph182010817>

Publisher's note

Bio-Byword Scientific Publishing remains neutral with regard to jurisdictional claims in published maps and institutional affiliations.

A Review of the Pharmacological Effects and Clinical Potential of *Angelica sinensis*

Jing Ma*, Shiyu Zhang, Wenya He, Pengliang Yun

Ningxia Medical University, Yinchuan 750002, Ningxia Province, China

*Corresponding author: Jing Ma, 18209617889@163.com

Copyright: © 2024 Author(s). This is an open-access article distributed under the terms of the Creative Commons Attribution License (CC BY 4.0), permitting distribution and reproduction in any medium, provided the original work is cited.

Abstract: As one of the widely used medicinal herbs with both medicinal and dietary applications in China, *Angelica sinensis* offers the advantage of “nourishing without causing stagnation” and has a variety of pharmacological effects, making it commonly applied in clinical practice and research. In recent years, as both domestic and international scholars have delved deeper into *Angelica sinensis*, its extensive pharmacological effects have garnered attention across various sectors of society. To date, *Angelica sinensis* has been shown to possess functions such as hematopoiesis, anti-inflammation, pain relief, anti-tumor effects, and immune enhancement. It is frequently employed to address conditions like intestinal dryness, constipation, vertigo, and palpitations. Additionally, *Angelica sinensis* has demonstrated significant potential and distinct therapeutic advantages in disease intervention, functional food development, and drug innovation. This review focuses on the pharmacological effects of *Angelica sinensis*, aiming to provide valuable scientific insights for its clinical application, drug innovation, and target development.

Keywords: *Angelica sinensis*; Pharmacological effect; Research

Online publication: November 27, 2024

1. Introduction

Angelica sinensis is listed in the *Shennong Bencao Jing* (*Shennong's Classic of Materia Medica*) as a traditional Chinese herbal medicine, widely utilized in clinical practice due to its warm nature and spicy taste. In recent years, research on the chemical components and pharmacological effects of *Angelica sinensis* has become more comprehensive, with its active components and clinical efficacy gaining substantial attention. This article elaborates on the traditional efficacy and modern pharmacological effects of *Angelica sinensis*, highlighting its broad application prospects across food, pharmaceutical, and biomedical fields ^[1].

2. Pharmacological activity

2.1. Pharmacological activity based on traditional efficacy

2.1.1. Invigorating and replenishing blood

The efficacy and therapeutic effects of *Angelica sinensis* are well-documented in traditional texts. In *Shennong Bencao Jing* (*Shennong's Classic of Materia Medica*), it is recorded as being effective for “treating women’s leakage and eliminating child-related issues.” According to *Bencao Qandao*, *Angelica sinensis* possesses blood-nourishing properties, making it primarily used for blood replenishment. Similarly, *Jingyue Quanshu Bencao Zheng* describes it as “the holy medicine of the blood.” Recent studies indicate that *Angelica sinensis* promotes blood circulation, improves hemorheology and microcirculation, and has anti-thrombotic functions. Therefore, in traditional Chinese medicine (TCM), *Angelica sinensis* is frequently used to treat conditions like vertigo, palpitations, blood deficiency, blood stasis, and dysmenorrhea, demonstrating favorable outcomes.

To deepen understanding of the pharmacological activity of *Angelica sinensis*, modern researchers have investigated its hematopoietic functions, particularly examining the role of *Angelica sinensis* polysaccharide (ASP) by observing hemoglobin levels in blood deficiency model rats. Interleukin-6 (IL-6) and granulocyte-macrophage colony-stimulating factor have been shown to stimulate the hematopoietic function of ASP under stimulated conditions. Further research has examined the effects of different components, such as acetophenhydrazine (APH), on blood deficiency in mice. Findings indicate that the hematopoietic potential of the water extract and alcohol precipitation supernatant (DSC) from *Angelica sinensis* is significantly stronger than that of other parts ^[2].

For example, in cases of “sports anemia,” caused by intense exercise, which induces oxidative stress and upregulates hepcidin, athletes often experience persistent “sports anemia.” Addressing this, scholars studied the efficacy of *Angelica sinensis* alcohol extract and found that it significantly improved red blood cell counts in female rats with exercise-induced anemia, thereby mitigating anemia resulting from strenuous exercise. Additionally, researchers discovered that *Angelica sinensis* alcohol extract plays an important role in regulating iron metabolism. Notably, the alcohol extract was observed to reduce serum alanine aminotransferase (ALT) levels, an indicator of liver injury, thus effectively alleviating prolonged running-induced anemia by enhancing the body’s antioxidant capacity and down-regulating hepcidin.

Renowned as a “blood tonic medicine,” *Angelica sinensis* plays a crucial role in supporting the hematopoietic system. Hematopoiesis within the body involves cellular proliferation, differentiation, and release, which contribute significantly to health maintenance. The mechanism by which *Angelica sinensis* promotes hematopoiesis is primarily through regulating the generation, proliferation, and differentiation of hematopoietic cells, as well as inhibiting apoptosis, thereby improving blood biochemical marker levels in the human body to maintain stability.

2.1.2. Regulating menstruation and relieving pain

Mingyi Bielu (*Other Records of Famous Doctors*) describes *Angelica sinensis* as “primarily warming and analgesic.” In clinical practice, beyond its use in treating gynecological dysmenorrhea, it is also effective in alleviating headaches, arthralgia, and neuralgia. Researchers have investigated the analgesic effects of certain chemical components of *Angelica sinensis*, focusing on anti-inflammatory pathways. Nerve growth factor (NGF) is known to play a role in pain enhancement, and ligustilide, an essential oil component of *Angelica sinensis*, has shown therapeutic effects on prostatitis in mouse models. This compound can effectively reduce

the expression of inflammatory substances in prostatitis tissue, thereby increasing the pain threshold in model mice by reducing the frequency of writhing behavior.

In TCM gynecology, *Angelica sinensis* is frequently used to treat dysmenorrhea in women. Dysmenorrhea is primarily caused by “hypothalamic-pituitary-ovarian axis disorder,” which *Angelica sinensis* can alleviate by inhibiting estrogen production. Additionally, severe contractions of the uterine smooth muscle contribute to dysmenorrhea, causing abdominal pain before and after menstruation. Experimental studies on the pharmacological effect of *Angelica sinensis* on menstrual pain relief found that model mice treated with its volatile oil exhibited significantly fewer writhing movements compared to those given normal saline [3]. Furthermore, due to the reduction of oxytocin, the amplitude and frequency of uterine smooth muscle contractions were markedly decreased.

In conclusion, the essential oil of *Angelica sinensis* effectively regulates menstruation and alleviates pain, showing a clear therapeutic effect on uterine smooth muscle spasms. Some researchers have further explored the effects of *Angelica sinensis* essential oil components on uterine contractility, discovering its bidirectional nature: small doses stimulate, while large doses inhibit uterine contraction. Through extensive efficacy screening, researchers identified the most effective component for inhibiting uterine contractions: neutral, non-phenolic fraction A3.

2.2. Pharmacological activity based on dilatational effect

2.2.1. Antitumor activity

Angelica sinensis polysaccharide, the primary active component of *Angelica sinensis*, exhibits significant antitumor effects through its pharmacological mechanisms. Both *in vivo* and *in vitro* experiments show that *Angelica sinensis* has notable antitumor activity. *In vivo*, ASP primarily inhibits tumor cell growth and metastasis by effectively stimulating the host immune system and inhibiting cancer cell adhesion. Scholars have reported that ASP can inhibit human leukemia K562 cells in a dose-dependent manner by promoting erythropoietin-mediated signal transduction and activating specific protein signaling pathways.

In vitro studies have identified a new *Angelica sinensis* component, polysaccharide APS-1d, which significantly inhibits cancer cell proliferation and induces apoptosis. Research has demonstrated that APS-1d shows anticancer activity against human cervical cancer HeLa cells by activating the intrinsic mitochondrial pathway to curb proliferation and promote apoptosis. Additionally, ASP has been effective in inducing apoptosis in T47D breast cancer cells by increasing the overexpression of cyclic adenosine response element-binding protein.

2.2.2. Liver protection

Various factors, such as unhealthy habits, alcohol, drug abuse, chemical exposure, and hyperlipidemia, can cause liver damage, disrupting the body’s metabolic regulation and leading to an imbalance in energy regulation across organs. Studies indicate that ASP plays a significant role in liver protection, positively impacting liver damage caused by various factors. In research on rats exposed to cadmium-induced immune and liver injury, a specific dose of ASP was found to alleviate liver damage, improve immune function, and enhance enzyme activity regulation to varying degrees. Studies also show that ASP effectively slows chronic liver fibrosis both *in vivo* and *in vitro*, achieving liver protection through its anti-inflammatory and antioxidant mechanisms. Furthermore, its cholesterol-lowering properties help reduce liver strain by decreasing fat accumulation and

regeneration, thereby promoting liver function protection.

Additionally, extensive experimental studies have demonstrated that the TCM compound preparation, *Astragalus-Angelica* mixture, exhibits beneficial effects, such as delaying chronic renal failure and improving protein and lipid metabolism. For instance, the *Astragalus-Angelica* mixture has been shown to enhance renal function and reduce the tubulointerstitial damage index in rats with chronic purinase-induced sclerosis. Chronic kidney disease often results in interstitial fibrosis and increased renal tubular epithelial cell atrophy. *Astragalus-Angelica* mixture provides a similar therapeutic effect to enalapril in treating this condition, although it does not exert its effects by blocking the renin-angiotensin system within the kidney. Instead, it protects the kidney by inhibiting the overexpression of transforming growth factor- β and osteopontin rather than activating renal cells.

2.2.3. Anti-Alzheimer's disease

Alzheimer's disease (AD), a common neurodegenerative disorder, impairs cognitive functions in older adults, affecting their independent thinking and memory and leading to a diminished quality of life. The pathological hallmark of Alzheimer's is amyloid- β (A β), which reduces the viability of neural 2A cells in a concentration-dependent manner. To address this cause of Alzheimer's, researchers administered a specific dose of *Angelica sinensis* extract to a small group of patients with neural cell dysfunction. The extract significantly reduced lesions caused by amyloid- β and helped prevent neurotoxicity induced by this marker. This illustrates the critical role of *Angelica sinensis* extract in inhibiting amyloid- β , emphasizing its unique value in anti-Alzheimer's research. Additionally, research has shown that the mediating pathway of *Angelica sinensis* extract involves phosphatidylinositol 3-kinase/protein kinase B/glycogen synthase kinase-3 β signaling, which reduces amyloid- β toxicity and protects the nervous system. Further studies on rat models with hippocampal inflammation suggest that ASP improves memory deficits in Alzheimer's rats by inhibiting inflammatory factors and reducing neuronal apoptosis ^[4].

2.2.4. Cardiovascular protection

Studies on chronic cardiotoxicity in mice indicate that *Angelica sinensis* water extract effectively improves heart performance and lowers mortality rates in model mice. The ASP water extract maintained normal levels of AST in serum and antioxidant activity in the organs of these mice, helping alleviate arrhythmia and conduction abnormalities, while also supporting the myofibrils in maintaining their activity. In studies on hypoxia-induced injury of H9c2 cardiomyocytes, ASP exhibited a protective effect, with treated cells showing increased survival and proliferation rates compared to the model group. *Angelica sinensis* plays a significant role in treating cardiovascular diseases and regulating angiogenesis, as it contains both anti-angiogenic and pro-angiogenic components, offering new directions in the development of angiogenesis regulators. Therefore, in TCM clinical practice, it is essential for medical staff and researchers to harness the pharmacological benefits of *Angelica sinensis* appropriately.

3. The antioxidant effect and mechanism of *Angelica sinensis*

The antioxidant effect of *Angelica sinensis* is notably distinct in current clinical applications. Throughout various endogenous and exogenous processes, the human body produces a large amount of reactive nitrogen oxides. When there is an imbalance between these reactive nitrogen oxides and the body's antioxidant defense

system, oxidative stress occurs. Clinically, antioxidants are frequently used to treat diseases related to oxidative stress. The antioxidant effect of ASP is primarily demonstrated by its antioxidant properties *in vitro*, which protect rat chondrocytes from oxidative stress damage. Studies have shown that ephedrine reduces antioxidant capacity in mouse liver tissue and activates tumor necrosis factor in mice.

In treating liver injury in mice, researchers found that ASP effectively counteracted liver damage caused by jute exposure, improving the organ's antioxidant capacity. Additionally, ASP has been shown to protect neurons from oxidase-induced cytotoxicity, effectively decreasing the number of apoptotic cells in the body and significantly raising reactive oxygen species levels in cells. Overall, ASP exhibits a strong antioxidant capacity, providing promising avenues for the development of natural antioxidant drugs.

4. The antihypertensive effect and mechanism of *Angelica sinensis*

Essential hypertension is a common chronic disease that can induce organ damage in the heart, brain, kidneys, and other areas, making it a significant risk factor for cardiovascular disease mortality. Studies have shown that *Angelica* alcohol extract can help maintain cellular balance by regulating mitogen-activated protein kinase, leading to a spontaneous reduction in blood pressure in hypertensive rats. This not only improves endothelial function and reverses ventricular remodeling in hypertensive rats but also effectively treats liver and kidney damage, enhancing the vitality of the affected animals.

Additionally, the pathogenesis of hypertension often involves vascular endothelial dysfunction. Some researchers have explored how *Angelica sinensis* might regulate vascular endothelial function to reduce hypertension incidence. In animal experiments, scholars discovered that the essential oil of *Angelica sinensis* exhibits pharmacological properties that spontaneously regulate hypertension in rats, acting through various intracellular enzyme signaling pathways. One critical mechanism involves reducing renin and angiotensin levels in blood vessels, as the renin-angiotensin-aldosterone system is closely linked to antihypertensive effects. By lowering renin and angiotensin levels, the essential oil of *Angelica sinensis* offers promising potential in developing new antihypertensive medications ^[5].

Furthermore, *Angelica sinensis* promotes antihypertensive effects by regulating lipid metabolism, inhibiting atherosclerosis, and facilitating blood pressure reduction. For instance, when using the essential oil of *Angelica sinensis* to up-regulate enzyme and gene expression levels, researchers found that it holds significant value in improving lipid metabolism in hypertensive rats. This effectively curtails atherosclerosis, contributing to blood pressure reduction and supporting *Angelica sinensis* as a valuable agent in antihypertensive treatment.

5. Conclusion

With advancements in modern science and technology, extraction, separation, and identification techniques for TCM have greatly improved, significantly enriching research on the chemical composition and pharmacological actions of TCM in our country. The pharmacological studies of *Angelica sinensis* not only reflect the profound and excellent culture of TCM but also substantiate the scientific basis of TCM theories. However, research on the pharmacological effects of *Angelica sinensis* remains somewhat limited. In recent years, academia has focused heavily on studying components within the essential oil of *Angelica sinensis* and examining the clinical activities and pharmacological effects of its different components. Unfortunately, the chemical components

of traditional decoctions have not been extensively analyzed. As an important clinical medicine, increased attention to the traditional decoction of *Angelica sinensis* could effectively broaden the research scope on its chemical composition and enhance the credibility of its pharmacological effects.

Disclosure statement

The authors declare no conflict of interest.

References

- [1] Yao J, Ma L, Ren Y, et al., 2024, Evaluation of the Difference Between The Formula Granule Decoction and Traditional Decoction Based on Chemical Composition and Pharmacological Effect of Angelica and Astragalus. Chinese Medicine Review, 43(7): 1112–1119.
- [2] Li X, Li S, Liu X, et al., 2024, Research Progress on Chemical Composition, Pharmacological Action and Clinical Application of Angelica sinensis and Ligusticum chuanxiong. Chinese Materia Medica, 55(4): 1415–1426.
- [3] Xu Z, Li J, Ma X, et al., 2024, Research Progress on Chemical Components and Pharmacological Effects of Different Medicinal Parts of Angelica sinensis. Chin J Traditional Chinese Medicine, 42(4): 74–77.
- [4] Wang M, Ma F, Tian C, et al., 2023, Research Progress of Chemical Composition, Pharmacological Action and Clinical Application of Danggui Sini Decoction and Prediction Analysis of Quality Marker (Q-Marker). Chinese Materia Medica, 54(3): 991–1001.
- [5] Xiang L, Zhang Q, Zhao Q, et al., 2022, Research Progress on Chemical Constituents, Pharmacological Effects and Clinical Application of Astragalus and Angelica. Chinese Herbal Medicine, 53(7): 2196–2213.

Publisher's note

Bio-Byword Scientific Publishing remains neutral with regard to jurisdictional claims in published maps and institutional affiliations.

The Practical Pathways of Enhancing Nursing Education in Medical Schools

Jie Mei^{1*}, Yichun Gao², Genxiao Ding¹, Yinbiao Wang²

¹Henan Provincial People's Hospital, Zhengzhou 450003, Henan Province, China

²Xinxiang Medical University, Xinxiang 453003, Henan Province, China

**Corresponding author:* Jie Mei, mei396284351@163.com

Copyright: © 2024 Author(s). This is an open-access article distributed under the terms of the Creative Commons Attribution License (CC BY 4.0), permitting distribution and reproduction in any medium, provided the original work is cited.

Abstract: The advancement of society and continuous improvements in the healthcare system have heightened the demands on professional nursing training, necessitating that nursing education better meet practical needs in an increasingly diversified medical environment. To address these requirements, the teaching approaches and assessment methods in nursing education should be reformed and updated. This study conducted a comprehensive analysis of the current state of nursing education and proposed potential pathways to enhance nursing education in medical schools. These pathways include implementing a student-centered teaching approach, incorporating various teaching activities, emphasizing the development of students' practical skills, and reforming assessment methods to cultivate well-rounded professionals. The application of these strategies will help improve the effectiveness of classroom teaching, deepen students' understanding of theoretical knowledge and practical skills, and thereby contribute to the improvement of nursing education quality.

Keywords: Nursing education; Enhancing pathways; Teaching approach; Practical skills

Online publication: November 26, 2024

1. Introduction

With ongoing improvements in medical standards and increasing societal demand, the training of nursing professionals has become increasingly challenging. Reports indicate that China's aging population is growing at an unprecedented rate^[1]. As of the end of 2023, nearly 297 million people were aged 60 or older, accounting for 21.1% of the total population, with projections suggesting this number will exceed 480 million by 2050. However, there is a significant shortage of elderly care personnel. In addition, with rapid advances in medical technology, nursing professionals face a continual need to update their knowledge and skills.

In this context, traditional teaching methods—primarily focused on classroom explanation and demonstration—cannot fully address the complexities of future medical environments or the demands of

modern nursing education. There is an urgent need to refine teaching, learning, and evaluation models to improve teaching quality, enhance nursing students' practical skills, and foster the coordinated development of students' practical and intellectual abilities.

This paper analyzes the current state of nursing education in China and presents practical pathways for enhancing nursing education in medical schools, aiming to provide a valuable reference for future studies in this area.

2. Current status of nursing education in medical schools

2.1. Lack of emphasis on practical skills and patient differences

Nursing primarily focuses on patient care, with core duties including assisting doctors, carrying out medical orders, and performing necessary nursing operations. Therefore, practical skills and the ability to address specific clinical needs are essential for nursing professionals. However, there are some shortcomings in the current curriculum design of nursing education, such as a lack of practical components and a disconnect between course content and job requirements. Additionally, current nursing practice education places excessive emphasis on standardized procedures, overlooking the impact of patient differences on nursing care ^[2]. It is well-recognized that patients' moods and cooperation are fundamental to effective nursing, and variations in patients' living and working environments can influence nursing procedures and methods. This oversight in teaching has contributed to nursing students' insufficient practical skills. Thus, there is a need to strengthen education in areas such as professional theory, practical skills, and professional ethics so that students can accurately assess patient conditions and provide more targeted care.

2.2. Insufficient interaction and improper evaluation of students

Traditional nursing education is largely lecture-based and exam-oriented, where teachers strictly adhere to textbook content and maintain a dominant role in the classroom without fostering meaningful interaction with students ^[3]. Furthermore, the teaching methods are relatively limited, often relying on verbal explanations and demonstrations. This one-dimensional approach fails to capture students' attention or engage their interest, leading to a superficial understanding of nursing work and often causing boredom in classes.

Current assessments in nursing education also reveal a disconnect between practical skills and theoretical knowledge. Some evaluations focus solely on test scores, neglecting students' proficiency in operational practices. Other assessments lack consideration for humanistic qualities, such as the service environment and the psychological experiences of patients. These issues hinder the effective cultivation of students' practical skills and ultimately affect the implementation of treatments and nursing measures. Given the practical nature of nursing work, formative evaluation—which measures students' progress in both theoretical and practical competencies throughout their studies—should be integrated into nursing education.

2.3. Neglect in cultivating the mental health of nursing students

Nurses are expected to communicate effectively with doctors, patients, and families, which requires nursing students to possess not only basic medical knowledge but also strong interpersonal communication skills. Nursing work frequently involves responding to emergencies and exposure to illness and death, placing a significant psychological burden on nurses and affecting their mental well-being. However, current nursing programs often overlook the development of students' psychological resilience.

Additionally, nursing professionals are expected to serve patients with empathy and compassion, considering patients' needs and addressing their questions and concerns with patience. The unique demands of the nursing environment, along with variability in patients' symptoms and recovery statuses, can contribute to job-related stress and negatively impact mental health ^[4]. Integrating psychological health training into nursing programs is essential to help students manage stress, develop resilience, and foster a positive work attitude for their future careers.

3. Practical pathways for enhancing nursing education in medical schools

3.1. Implementing a student-centered teaching mode

Nursing professionals need the ability to make quick decisions and take necessary actions in complex medical environments. Traditional teaching, where teachers primarily serve as knowledge providers and students passively receive information, lacks sufficient interaction between teachers and students. This approach emphasizes memorization over understanding, analysis, and application, and it focuses more on theoretical knowledge than practical experience, making it challenging for students to adapt to real-world job roles. To fully engage students and effectively cultivate their practical skills, it is essential to adopt a student-centered teaching mode in nursing education.

Student-centered teaching allows students to have influence over the content, activities, and other aspects of their learning ^[5]. This approach emphasizes the active role of students in knowledge construction and skill development. In this mode, students are no longer passive listeners in the classroom but active participants. Before class, relevant learning resources are made available on an online platform, allowing students to preview content and consider guiding questions that promote independent learning. During class, various teaching models such as flipped classrooms and split classrooms can be used to address questions through discussion, debate, and interaction. After class, additional learning materials, post-class exercises, and mock tests are provided on the platform. The integration of pre-class, in-class, and post-class activities through online and offline teaching—as well as individual and collaborative learning—can help maximize teaching efficiency.

In the classroom, teachers are encouraged to use role-playing, group collaboration, and scenario-based training to deepen students' understanding and foster their problem-solving abilities and teamwork skills. Simulating real medical scenarios using virtual reality technology and anatomical models enables students to practice handling various nursing situations and refine their operational skills, such as vital sign monitoring, medication administration, and basic life support ^[6]. Moreover, designing specific nursing tasks that address real problems in emergency response training and internships allows students to apply their knowledge and skills in actual work settings, enhancing their practical abilities and problem-solving skills.

To meet the practical needs of nursing work, course content should also be updated to reflect the latest research findings in medicine and nursing. Recent advancements in nursing practice, new textbooks, online courses, and other learning resources need to be incorporated promptly into the curriculum. Additionally, experts and practitioners from the medical field are encouraged to give lectures or host seminars to provide students with insights into current career trends and challenges.

3.2. Involving various teaching activities

Diversified teaching activities can stimulate students' interest in learning and improve their engagement. In

nursing education, methods such as situational teaching, case-based teaching, problem-based teaching, and team-based teaching can help engage students more actively with course content. For example, multimedia technology can vividly present theoretical knowledge, such as the distribution of bones and layered muscles, addressing students' challenges with spatial perception. Additionally, virtual reality and simulation technology can create a safe environment for students to practice clinical skills without the risk of harm to patients ^[7]. With the simulation of human-like vital signs, such as pulse, respiration, and chest movement, simulators can exhibit behaviors like blinking and coughing and respond appropriately to nursing interventions. For example, in a sudden cardiac arrest scenario, the simulator can display patient symptoms under pre-programmed settings. Consequently, nursing students are trained to collaborate, make quick decisions, and perform tasks such as chest compressions, bag-mask ventilation, defibrillation, and medication administration according to a doctor's orders ^[8]. Students can also rotate roles to develop decision-making skills across different roles through repeated practice. The presentation of complex clinical nursing scenarios and group collaboration can cultivate students' clinical thinking skills and teamwork abilities, laying a strong foundation for their future work.

In addition, diverse teaching formats, including group collaboration, case analysis, project-based learning, and practical exercises, can be used to help students acquire relevant professional skills more effectively. For example, in case analysis, teachers present clinical cases commonly encountered in the medical field and encourage students to gather case information and nursing procedures each week ^[9]. Students then participate in group discussions on key challenges in the treatment and nursing care of the patient. Finally, the teacher summarizes the main points of the case and introduces recent developments relevant to the case. Throughout this process, teachers also guide students to consider patients' immune status and their living and working environments. This exploration of illness causes and nursing methods in case analyses deepens students' understanding of nursing knowledge in a practical context.

3.3. Focusing on the cultivation of students' practical abilities

Nursing is an evolving field shaped by advancements in medical technology and clinical innovation. A key indicator of success in nursing education is whether students can effectively perform their roles upon graduation. Therefore, nursing education should be employment-oriented to ensure that students can quickly adapt to their positions and fully utilize their abilities. Additionally, nursing programs should incorporate the latest research and cutting-edge technological applications to inspire students' academic interests and better prepare them for future practical work.

Teachers can leverage clinical materials and case studies to stimulate nursing students' curiosity and interest in the profession, as well as to develop their sense of job-related responsibilities ^[10]. Using real cases enhances students' understanding of professional knowledge, increases their awareness of practical nursing issues, and helps them adapt to various medical scenarios. Moreover, inviting professional nursing staff from local hospitals to serve as instructors who can explain essential practical details from actual nursing processes can further strengthen students' competencies.

Clinical internships are an effective way for nursing students to develop practical skills and gain experience in handling complex medical cases. Schools can actively collaborate with hospitals, clinics, community health centers, and other medical institutions to provide students with clinical practice opportunities and hands-on learning experiences. A typical example of this is the compulsory rotatory residential internship ^[11]. By rotating through departments such as internal medicine, surgery, gynecology, and pediatrics, students can refine their

hands-on skills and operational abilities across various clinical practices. Additionally, investing in medical equipment is essential to support effective practical training.

3.4. Reforming assessment to cultivate comprehensive talents

Assessment is a vital tool for understanding students' academic progress and practical abilities. However, traditional written exams are insufficient for evaluating students' overall capabilities, as they often fail to test students' skills in real-world scenarios. Thus, it is important to align assessments more closely with the requirements of actual nursing work. In nursing education, students should be assessed through a combination of theoretical and practical evaluations. Theoretical assessments should be relevant to clinical practice and focus on students' problem-solving and analytical abilities. To provide a structured assessment framework, a pyramid model can be used, focusing on students' knowledge retention, comprehension, and practical abilities ^[12].

For practical skills assessment, a virtual standardized patient (VSP)-based approach can help eliminate teacher subjectivity, enabling objective and standardized evaluations ^[13]. VSP assessments can evaluate students' clinical decision-making skills by allowing them to repeatedly practice history-taking and nursing responses ^[14]. For example, students' abilities to make clinical judgments in cases such as stroke, acute abdomen, and asthma can be tested using VSP scenarios in emergency contexts. This method integrates theory and practice within a clinical framework, offering the advantage of clinical relevance, though it does require significant time and resources.

Additionally, assessments should consider students' humanities awareness and clinical reasoning abilities. In addition to end-of-term exams, regular, experimental, and midterm assessments can provide teachers with a comprehensive view of students' skill development over the semester. Furthermore, by evaluating students' ongoing performance, teachers can address questions in a timely manner and provide targeted assistance, thereby enhancing students' learning and practical skills.

4. Conclusion

In the modern era, nursing education holds the critical responsibility of developing highly competent nursing professionals equipped with strong theoretical knowledge and practical skills. To better prepare nursing students for future developments in the medical field, several strategies are required to improve the current approach to nursing education. This study proposed four specific pathways to strengthen nursing education in medical schools: implementing a student-centered teaching model, incorporating diverse teaching activities, emphasizing the cultivation of students' practical abilities, and reforming assessments to develop comprehensive skills. Adopting these strategies will help enhance students' practical competencies, stimulate their academic interests, and encourage proactive learning habits.

Funding

- (1) Open Research Project of Henan Provincial Key Medicine Laboratory of Nursing (HNSYHLKT202303 and HNSYXZKT202441)
- (2) Henan Provincial Key Scientific Programs for Universities (25A330004)
- (3) Henan Provincial Innovative Training Program for Undergraduates (S202410472013)

Disclosure statement

The authors disclose no conflict of interest.

References

- [1] Feng Z, Wu B, 2023, Embracing Challenges for Population Aging in China: Building Scientific Evidence to Inform Long-Term Care Policymaking and Practice. *J Aging Soc Policy*, 35(5): 543–553. <https://doi.org/10.1080/08959420.2023.2217979>
- [2] Wu C, 2024, Reflections on the Reform of Nursing Education in Universities under the Concept of Precision Nursing. *Learning Weekly*, 2024(19): 21–24.
- [3] Zhang Y, 2022, Research on the Reform Path of Enhancing Basic Nursing Education in Higher Vocational Nursing Programs. *Learning Weekly*, 2022(13): 3–5.
- [4] Wei L, Guo Z, Zhang X, et al., 2023, Mental Health and Job Stress of Nurses in the Surgical System: What Should We Care. *BMC Psychiatry*, 23(1): 871. <https://doi.org/10.1186/s12888-023-05336-0>
- [5] Zhang Y, 2024, The Reform Path of Student-centered Teaching Model for Vocational Nursing Programs. *Asia-Pacific Education*, 2024(10): 176–178.
- [6] Macnamara A, Bird K, Rigby A, et al, 2021, High-fidelity Simulation and Virtual Reality: An Evaluation of Medical Students' Experiences. *BMJ Simulation & Technology Enhanced Learning*, 7(6): 528–535. <https://doi.org/10.1136/bmjstel-2020-000625>
- [7] Liang Y, Wang J, Zhu J, et al., 2023, Analysis of the Reform Path for Nursing Education under the Perspective of Educational Informatization. *Survey of Education*, 12(7): 115–117 + 124.
- [8] Sun M, Di X, Hao C, et al., 2022, Application of Virtual Simulation Technology Combined with PBL in the Teaching of Critical Care Nursing. *China Higher Medical Education*, 2022(8): 121–122.
- [9] Jin L, Yao W, 2022, Practice Teaching Reform of Nursing Specialty Based on Skills Competition. *Journal of Liaoning Higher Vocational*, 24(2): 74–78.
- [10] Sun W, Liu K, 2023, Preliminary Exploration of Nursing Education Reform Based on Skill-Oriented Talent Development. *Knowledge World*, 2023(10): 12–14.
- [11] Haynes-Ferere A, Muirhead L, Hayes R, McCauley L, 2024, The Growth and Development of a Novel Distance Accelerated Bachelor of Science in Nursing Program. *Journal of Professional Nursing*, 54: 1–9. <https://doi.org/10.1016/j.profnurs.2024.04.009>
- [12] Cruess R, Cruess S, Steinert Y, 2016, Amending Miller's Pyramid to Include Professional Identity Formation. *Academic Medicine*, 91(2): 180–185. <https://doi.org/10.1097/ACM.0000000000000913>
- [13] Herbstreit F, Merse S, Schnell R, et al., 2017, Impact of Standardized Patients on the Training of Medical Students to Manage Emergencies. *Medicine (Baltimore)*, 96(5): e5933. <https://doi.org/10.1097/MD.0000000000005933>
- [14] Du J, Zhu X, Wang J, et al., 2022, History-taking Level and Its Influencing Factors among Nursing Undergraduates Based on the Virtual Standardized Patient Testing Results: Cross Sectional Study. *Nurse Education Today*, 111: 105312. <https://doi.org/10.1016/j.nedt.2022.105312>

Publisher's note

Bio-Byword Scientific Publishing remains neutral with regard to jurisdictional claims in published maps and institutional affiliations.

Research on Teaching Reform of Pathology Courses in Colleges and Universities under the Background of “Internet plus New Medical Science”

Ziwei Hong*

Xi'an Fanyi University, Xi'an 710105, Shaanxi Province, China

*Corresponding author: Ziwei Hong, Jintian119119@126.com

Copyright: © 2024 Author(s). This is an open-access article distributed under the terms of the Creative Commons Attribution License (CC BY 4.0), permitting distribution and reproduction in any medium, provided the original work is cited.

Abstract: With the advent of the era of “Internet plus New Medical Science,” the teaching mode for pathology courses in colleges and universities faces unprecedented opportunities for transformation. In this context, a pathology teaching model centered on theoretical explanations alone can no longer fully meet the demands of modern medical education. Therefore, it is essential to study and explore pathways for reforming pathology teaching in higher education within the framework of “Internet plus New Medical Science.” Research reveals a series of issues in current pathology teaching in universities, such as the uneven distribution of teaching resources, limited teaching methods, a disconnect between theory and practice, and incomplete evaluation systems. To address these challenges, universities should adopt a series of measures: optimizing resource allocation, innovating teaching methods and approaches, strengthening the integration of theory and practice, enhancing evaluation systems, and building robust teaching teams. These reforms aim to stimulate students’ interest in learning and improve the effectiveness of pathology instruction.

Keywords: Internet plus New Medical Science; Universities; Pathology; Teaching model

Online publication: November 27, 2024

1. Introduction

The *Opinions on Deepening the Reform of Undergraduate Education and Teaching and Improving the Quality of Talent Cultivation*, issued by the Ministry of Education, emphasizes the importance of “actively developing ‘Internet plus education,’ exploring new forms of intelligent education, and promoting a revolution in classroom teaching”^[1]. Pathology, a critical component of medical education, serves as a bridge between basic and clinical medicine, introducing students to disease recognition and providing foundational knowledge essential for lifelong medical practice. Consequently, the quality of pathology teaching directly influences students’ clinical

diagnostic skills and their capacity for scientific research and innovation. Traditionally, pathology instruction has relied on classroom lectures and laboratory sessions; however, this model alone no longer meets the needs of modern medical education due to rapid technological advancements. The broad application of Internet technology has introduced new perspectives and tools for pathology instruction, diversifying and personalizing the teaching model. Particularly in the context of the development of new medical sciences, the teaching mode for pathology courses in colleges and universities must evolve with the times, leveraging Internet technology to optimize teaching resources and foster innovation in teaching methods.

2. Existing problems in the teaching of pathology courses in universities

2.1. Uneven distribution of teaching resources

In the traditional pathology teaching model, there is often an imbalance in the allocation of teaching resources. Variations in geographical location, funding, and faculty strength among universities lead to disparities in pathology resources. For example, some universities may lack advanced experimental equipment and sufficient teaching samples, limiting students' practical opportunities in the learning process. Additionally, disparities exist in the availability of highly qualified teachers, with some institutions struggling to attract and retain experienced pathology instructors. This imbalance ultimately impacts teaching quality and student learning outcomes.

2.2. Single teaching method

Traditional pathology teaching often centers around a teacher-led, lecture-based approach with minimal student engagement. This one-way teaching method makes it difficult to stimulate students' interest and motivation, resulting in a lack of enthusiasm and creativity in learning ^[2]. Furthermore, due to the complex and specialized nature of pathology content, a single teaching approach does not accommodate the diverse learning needs of students, which hinders comprehension for some and reduces learning effectiveness.

2.3. Disconnect between practice and theory

In traditional pathology teaching, a significant gap often exists between theoretical instruction and practical application. Students find it challenging to fully apply theoretical knowledge gained in class to laboratory practice, creating a disconnect between learning and real-world application ^[3]. This gap limits students' understanding of pathology and reduces their ability to solve practical problems. Laboratory exercises are often restricted to a limited number of specimens and equipment, making it difficult to cover the broad field of pathology and to adequately prepare students for complex and varied clinical scenarios.

2.4. Incomplete evaluation system

The evaluation system in pathology courses strongly influences students' learning motivation and teachers' instructional methods. However, traditional evaluation systems tend to be overly simplistic, often relying solely on final exam scores to assess student performance. This approach neglects students' progress throughout the course and does not emphasize the development of practical skills, leading students to focus excessively on exam results while overlooking the practical applications of pathology knowledge ^[4]. Additionally, the evaluation system lacks assessments of students' innovation and critical thinking skills, making it difficult to accurately reflect their actual competencies.

3. Teaching reform path of pathology courses in colleges and universities under the background of “Internet plus New Medical Science”

3.1. Optimize the allocation of teaching resources

In the context of “Internet plus New Medical Science,” colleges and universities should leverage digital resources and network platforms to enhance the distribution and utilization of pathology teaching resources. By establishing a comprehensive online pathology resource library, high-quality teaching materials can be shared effectively, narrowing the gap in resource allocation among universities. For instance, institutions can develop virtual laboratories that allow students to perform simulated experiments online ^[5]. This approach not only compensates for the limitations of physical lab resources but also provides a more flexible and convenient learning experience. Utilizing online platforms for remote pathology instruction allows renowned experts, both domestic and international, to deliver lectures and teach online ^[6]. This enriches the curriculum content and provides students with access to the latest pathology knowledge and research. This model enables students to overcome geographical barriers, thereby receiving a higher quality of education and improving overall teaching effectiveness. Additionally, this approach helps foster students’ self-learning and information technology skills, laying a solid foundation for their future careers in the medical field.

3.2. Innovative teaching methods and tools

To keep pace with the “Internet plus New Medical Science” trend, colleges and universities need to innovate the teaching methods and tools used in pathology courses. First, a flipped classroom model can be adopted, where students learn the fundamentals of pathology independently on online platforms before class, while in-class time is used for discussions, case analyses, and experimental operations. This model increases student engagement, fosters enthusiasm and initiative, and cultivates critical thinking and problem-solving skills ^[7]. Additionally, virtual reality (VR) and augmented reality (AR) technologies can enhance the learning experience by providing more intuitive and vivid insights ^[8]. For example, in studying structural organization and pathological processes, VR technology allows students to explore a 3D virtual space to observe and analyze various pathological changes, making these concepts more accessible than traditional 2D images and text. AR can present abstract concepts and complex structures in an augmented format, aiding students in understanding and retention ^[9]. Moreover, by leveraging big data and artificial intelligence, universities can analyze students’ online learning behaviors to provide personalized recommendations for resources and learning advice. This approach tailors the content and teaching methods to meet students’ specific needs, improving learning efficiency.

3.3. Strengthen the integration of theory and practice

Under the “Internet plus New Medical Science” framework, pathology courses in colleges should prioritize the integration of theory and practice to enhance students’ clinical application abilities. First, a virtual simulation platform can bridge theoretical knowledge with clinical practice, allowing students to perform practical operations in a simulated clinical environment. This method enables students to practice and reinforce their knowledge without time and space constraints, improving both clinical reasoning and technical skills ^[10]. Furthermore, universities can collaborate with hospitals to establish clinical pathology practice bases, giving students the opportunity to participate in real case analyses and diagnostic processes. Through interaction with clinical practitioners, students gain a deeper understanding of how pathological knowledge is applied in clinical diagnosis, which strengthens their grasp of theoretical concepts ^[11]. Additionally, universities can facilitate

online case discussions and remote pathology diagnostics, enabling students to engage in real case analyses. Through collaborative discussions and exchanges, students enhance their clinical thinking and problem-solving abilities. These activities allow students to not only bridge theoretical knowledge with practical cases but also develop teamwork and communication skills.

3.4. Improve the teaching evaluation system

In the context of “Internet plus New Medical Science,” the evaluation system for pathology courses in colleges and universities should be reformed and enhanced to align with the new teaching modes and training objectives. First, a diversified evaluation system should be established, incorporating not only traditional final exams but also comprehensive assessments of student’s practical skills, case analysis, group discussions, online learning progress, and quality of work. This diversified evaluation approach allows for a more comprehensive reflection of students’ learning outcomes and practical application abilities ^[12]. Additionally, formative assessments should be introduced to continuously track students’ progress throughout the teaching process, using regular assignments, quizzes, lab reports, and classroom performance. Formative evaluation helps identify issues students may face during learning and provides targeted guidance and support to promote continuous improvement. Furthermore, universities can leverage big data and artificial intelligence to analyze students’ online learning behaviors and outcomes, thereby offering personalized feedback and suggestions ^[13]. This method helps students better understand their learning status, adjust their strategies in a timely manner, and improve learning outcomes. Finally, universities should encourage self-evaluation and peer evaluation among students to foster self-reflection and critical thinking. These evaluations help students recognize their strengths and weaknesses, enabling them to make targeted improvements in future learning.

3.5. Strengthen the construction of the teaching staff

In the “Internet plus New Medical Science” context, pathology curriculum reform requires not only advanced resources and methodologies but also a high-quality teaching team. Universities should prioritize training pathology teachers, enhancing their ability to integrate modern information technology into teaching, and enabling them to effectively use tools like online platforms, virtual reality, and augmented reality. Additionally, teachers should continuously update their professional knowledge to stay aligned with the latest developments in pathology, ensuring that students receive cutting-edge knowledge ^[14]. Universities can also engage experienced clinicians as part-time instructors or guest lecturers to bring real cases from clinical practice into the classroom, enriching the relevance and vividness of teaching. These part-time instructors can provide practical insights and career guidance, helping students understand the real-world applications of pathology. Furthermore, universities should encourage interdisciplinary collaboration among faculty to integrate pathology with other medical fields, cultivating students’ comprehensive analytical abilities and interdisciplinary thinking ^[15]. Through teamwork, faculty can collaboratively develop new teaching modules and courses, ensuring pathology education aligns more closely with clinical needs. Finally, universities should establish incentive mechanisms to encourage teachers in their efforts toward instructional reform and innovation. Through teaching awards and research funding, universities can stimulate teachers’ enthusiasm and creativity, promoting continuous improvement and development in pathology instruction. These measures help universities cultivate more pathology professionals with strong theoretical foundations and practical skills, ultimately contributing to advancements in the medical field.

3.6. Promote interdisciplinary cooperation and exchange

In the “Internet plus New Medical Science” era, reforming pathology curricula in universities should also focus on fostering interdisciplinary cooperation and exchange to promote knowledge integration and innovation. Universities can establish interdisciplinary teaching and research platforms, encouraging pathology educators to collaborate with experts from other fields, such as medical disciplines, computer science, and bioinformatics. Through these partnerships, they can jointly develop course content and teaching projects that integrate knowledge from multiple fields, offering students a broader knowledge base and diverse problem-solving perspectives. Additionally, universities should encourage students to participate in interdisciplinary research projects, helping them develop comprehensive analytical skills and innovative problem-solving abilities through hands-on work and teamwork. These interdisciplinary collaborations and exchanges make pathology courses in universities more diverse and adaptable to the evolving needs of the medical field.

4. Summary

In summary, in the context of “Internet plus New Medical Science,” reforming the pathology curriculum in colleges and universities is essential and urgent. Universities should innovate teaching methods and approaches, strengthen the integration of theory and practice, improve the evaluation system, and enhance the development of the teaching faculty. These efforts aim not only to improve the quality and effectiveness of pathology education but also to cultivate students’ clinical application abilities, stimulate their interest in learning, and enhance their critical thinking and problem-solving skills. Ultimately, these reforms will help develop medical professionals with comprehensive, well-rounded qualities.

Disclosure statement

The author declares no conflict of interest.

References

- [1] Zhang H, Zou B, Zhang H, 2024, Exploration of Online and Offline Integrated Hybrid Teaching in Pathology. *Journal of Hebei North University (Natural Science Edition)*, 40(8): 48–50.
- [2] She Y, Li Y, Huang Y, et al., 2024, Construction and Practice of Digital Resource Database for Experimental Teaching of Pathology Course from the Perspective of “New Medical Science” – A Case Study of School of Basic Medicine of Gansu University of Chinese Medicine. *Journal of Northwest University for Nationalities (Natural Science Edition)*, 45(2): 79–84.
- [3] Zheng H, Zhang J, Wu Q, et al., 2024, Exploratory Research on Online and Offline Teaching of First-Class Pathology Course. *Modern Vocational Education*, 2024(15): 117–120.
- [4] Lv Y, Li X, Jin C, et al., 2024, Exploration and Practice of “Five Fusion” Teaching Model of Pathology Course Under the Background of New Medical Science. *Continuing Medical Education*, 38(2): 29–32.
- [5] Yu W, Ma X, Ling C, et al., 2024, Exploration and Practice of Pathophysiology Course Teaching Reform in the Context of New Medical Science. *China Continuing Medical Education*, 16(3): 17–20.
- [6] Pu W, Gao R, Lin D, et al., 2024, Exploration of the Teaching Innovation Path of Pathology in the Context of “New Medical Science”. *Chinese Journal of Continuing Medical Education*, 16(2): 31–36.

- [7] Gao J, Li R, Meng S, et al., 2023, Application of the Integration of Ideology, Politics and Case Studies in Pathophysiology Curriculum Under the Background of “Internet +”. *Science Advisory (Education Research)*, 2023(12): 110–113.
- [8] Wang L, 2023, Construction of “Internet + CBL” Online and Offline Hybrid Teaching of Pathology Experiment in the Background of Ideological and Political Education. *Chinese Higher Medical Education*, 2023(11): 140–141.
- [9] Zhao L, Li Q, Hu Y, et al., 2023, Practice and Exploration of Training Interdisciplinary Talents in Pathology Based on Clinical Case Teaching Under the Background of New Medical Science. *Medical Teaching Research in Universities (Electronic Edition)*, 13(4): 19–22.
- [10] Zhao Y, Lin Y, Li G, et al., 2023, Application of Blended Teaching Based on Internet Learning Platform in Pathophysiology Teaching. *Chinese Journal of Continuing Medical Education*, 15(9): 32–36.
- [11] Zhang S, Jin X, Huang Q, et al., 2022, Discussion on the Implementation of Ideological and Political Teaching of Pathology Course Under the Background of New Medical Science – Taking Medical Imaging Technology Major as An Example. *Western Quality Education*, 8(4): 55–57.
- [12] Deng Z, Hu Y, Xiao D, et al., 2020, Thinking on Pathology Teaching in the Context of New Medicine. *Journal of Science and Education Guide (Mid Month)*, 2020(29): 59–60.
- [13] Lu X, Tao L, Yao Y, et al., 2020, A Preliminary Study on the Teaching Mode of Pathology in Colleges and Universities Under the Background of “Internet + Education”. *Contemporary Educational Practice and Teaching Research*, 2020(7): 3–4.
- [14] Wei C, Li Y, Li S, et al., 2019, Research on PBL Based Micro-Course Teaching and Its Application in the Context of “Internet +” – A Case Study of Pathology Course. *Journal of Minzu University of China (Natural Science Edition)*, 28(3): 70–75.
- [15] Fu Z, Chen L, 2018, Discussion on Oral Histopathology Teaching Model in Colleges and Universities Based on “Internet +” Mobile Phone Classroom. *Chinese Higher Medical Education*, 2018(2): 70–71.

Publisher’s note

Bio-Byword Scientific Publishing remains neutral with regard to jurisdictional claims in published maps and institutional affiliations.

Umbilical Cord Mesenchymal Stem Cell-Derived Exosomes Inhibit the Proliferation and Invasion of Uterine Fibroblast Cells

Hai Tang^{1,2}, Xin Luo^{1,2}, Xiuyin Shen^{1,2}, Yingchun Wan^{1,2}, Zhengping Liu^{1,2*}

¹Foshan Fetal Medicine Research Institute, Foshan Women and Children Hospital, Foshan 528000, Guangdong Province, China

²Department of Obstetrics, Foshan Women and Children Hospital, Guangdong Medical University, Foshan 528000, Guangdong Province, China

*Corresponding author: Zhengping Liu, liuzphk81@outlook.com

Copyright: © 2024 Author(s). This is an open-access article distributed under the terms of the Creative Commons Attribution License (CC BY 4.0), permitting distribution and reproduction in any medium, provided the original work is cited.

Abstract: *Objective:* To investigate the effects of exosomes derived from human umbilical cord mesenchymal stem cells (hUC-MSC) on the proliferation and invasion capacities of uterine fibroblast cells. *Methods:* Exosomes were isolated from the hUC-MSC culture medium via ultracentrifugation. The morphology, particle size, and surface markers of the hUC-MSC-derived exosomes (hUC-MSC-exo) were characterized using transmission electron microscopy (TEM), nanoparticle tracking analysis (NTA), and Western blotting. The impact of the exosomes on uterine fibroblast proliferation and invasion was assessed using the CCK-8 proliferation assay and Transwell invasion assays. *Results:* The exosomes exhibited a typical bilayer membrane structure with a diameter of 100–150 nm, and their average particle size was approximately 130 nm. The zeta potential was around -33 mV. Specific exosome markers, including CD9, TSG101, and CD63, were prominently expressed. Functionally, hUC-MSC-exo significantly inhibited the proliferation and invasion of uterine fibroblast cells. *Conclusion:* This study reveals the inhibitory effects of hUC-MSC-derived exosomes on uterine fibroblast proliferation and invasion, highlighting their potential therapeutic value. These findings provide new insights into the mechanisms underlying uterine scarring and suggest novel approaches for pharmacological treatment.

Keywords: Umbilical cord mesenchymal stem cells; Exosome; Uterine fibroblast cells; Proliferation; Invasion

Online publication: November 28, 2024

1. Introduction

The uterus is a vital organ in the female reproductive system, essential for pregnancy and menstruation ^[1]. Uterine scarring, often a consequence of surgeries such as cesarean sections or myomectomies, results in fibrotic lesions within the myometrium ^[2]. This condition can impair uterine function, increasing the risk of

uterine rupture in subsequent pregnancies and, in severe cases, posing significant risks to maternal and fetal health ^[2]. Uterine fibroblast cells are pivotal in maintaining uterine tissue homeostasis, facilitating tissue repair, and supporting regeneration ^[3]. In addition to their role in endometrial reconstruction and repair, uterine fibroblast cells are key participants in myometrial fibrotic processes and scar formation ^[4]. Following uterine surgeries, delivery-related injuries, or ectopic pregnancies, the proliferative and invasive behavior of uterine fibroblast cells can become dysregulated, contributing to uterine scar development, which in turn affects fertility and uterine functionality ^[4]. Current treatment strategies for uterine scarring are often inadequate; surgical interventions have high recurrence rates, and hormone-based therapies can lead to adverse side effects with prolonged use ^[5]. Hence, identifying effective interventions to enhance UF function, promote normal uterine recovery, and reduce scarring is critically important.

In recent years, human umbilical cord mesenchymal stem cells (hUC-MSC) have garnered attention in regenerative medicine due to their potent differentiation abilities and immunomodulatory properties ^[6,7]. However, clinical applications of hUC-MSC face challenges, including issues with transportation, maintaining biological activity, and quantifying active therapeutic components ^[8]. Exosomes, one of the paracrine products secreted by stem cells, offer a promising alternative. These extracellular vesicles (EVs), with diameters from 10 to 100 nm, are found in nearly all eukaryotic biological fluids and are rich in proteins, mRNA, miRNA, and other biomolecules ^[9]. Exosomes exhibit similar functions to stem cells but with lower immunogenicity and no oncogenic risk ^[9]. In fibrotic diseases, hUC-MSC has been shown to modulate the local microenvironment and promote tissue repair through exosome secretion ^[10]. Exosomes derived from hUC-MSC (hUC-MSC-exo) have demonstrated anti-fibrotic effects in models of liver fibrosis and other pathologies [10]. However, the specific effects of hUC-MSC-exo on uterine fibroblast cells remain unclear.

This study aims to investigate the regulatory effects of hUC-MSC-exo on the proliferation and invasion of uterine fibroblast cells. Exosomes were isolated from the hUC-MSC culture medium using ultracentrifugation, and their morphology, particle size, and surface markers were characterized by transmission electron microscopy (TEM), nanoparticle tracking analysis (NTA), and Western blotting. Subsequently, the effects of the exosomes on UF proliferation and invasion were evaluated using the CCK-8 assay and Transwell invasion assay. The findings of this study provide experimental evidence supporting the development of novel exosome-based therapeutic strategies for treating uterine scarring and offer insights into potential applications of stem cell-derived exosomes in gynecological diseases.

2. Methods

2.1. Culture of human uterine fibroblast cells and human umbilical cord mesenchymal stem cells (hUC-MSC)

Human uterine fibroblast cells were purchased from Procell Life Science & Technology Co., Ltd. (Wuhan, China) and cultured in Dulbecco's Modified Eagle Medium (DMEM, Gibco) supplemented with 10% fetal bovine serum (FBS, Gibco) and 1% penicillin/streptomycin. The cells were maintained in a humidified incubator at 37°C with 5% CO₂. Human umbilical cord mesenchymal stem cells (hUC-MSC) were obtained from Beijing Hanshi United Biotechnology Co., LTD (Beijing, China). These cells are known for their expression of various stem cell-specific markers and their strong proliferative and differentiation capabilities. hUC-MSC were cultured in F12 medium (Hyclone) with 10% FBS and 1% penicillin/streptomycin.

2.2. Isolation of exosomes from hUC-MSC

Exosomes were isolated from hUC-MSC at passages 4–6. When the cells reached approximately 80% confluence, the culture medium was removed, and the cells were washed three times with phosphate-buffered saline (PBS). The medium was replaced with serum-free medium, and the cells were incubated for an additional 48 hours at 37°C in a humidified atmosphere with 5% CO₂. The conditioned medium was collected and subjected to a series of centrifugation steps. Initially, the medium was centrifuged at 300 × g for 10 minutes to remove cells, followed by centrifugation at 2,000 × g for 10 minutes to eliminate dead cells. The supernatant was further centrifuged at 10,000 × g for 30 minutes to remove cell debris. Finally, the supernatant was subjected to ultracentrifugation (Beckman) at 100,000 × g for 70 minutes to obtain a crude exosome pellet. The exosome pellet was resuspended in PBS and centrifuged again at 100,000 × g for 70 minutes to purify the hUC-MSC-derived exosomes (hUC-MSC-exo).

2.3. Nanoparticle tracking analysis (NTA) of exosomes

The size distribution and concentration of exosomes were measured using ZetaView 8.04.02 software (Particle Metrix, Meerbusch, Germany). Exosome samples were diluted appropriately in 1X PBS buffer, and particle size and concentration were analyzed across 11 positions using nanoparticle tracking analysis (NTA). The ZetaView system was calibrated using 110 nm polystyrene particles, and the temperature during measurements was maintained between 23°C and 30°C.

2.4. Morphological identification of exosomes

Exosomes from hUC-MSC were resuspended in 100 µL of 2% paraformaldehyde (PFA) for fixation. A 5 µL droplet of the suspension was applied to a copper grid covered with Formvar and a carbon film. The grid was incubated with 50 µL of 1% glutaraldehyde for 5 minutes to enhance fixation, followed by a 2-minute wash in 100 µL of deionized water. The grid was then stained with 50 µL of uranyl oxalate solution for 5 minutes and treated with 50 µL of methylcellulose solution for 10 minutes. Excess liquid was removed with filter paper, and the grid was air-dried for 10 minutes before examination under a transmission electron microscope (TEM) at 80 kV.

2.5. Detection of exosome-specific protein markers

Exosome-specific surface markers were detected using Western blot analysis. Exosomal proteins were extracted from hUC-MSC-exo, and their concentrations were quantified with a BCA protein assay kit. After adding the loading buffer, the samples were boiled for 5 minutes to denature the proteins. The proteins were separated by SDS-PAGE, transferred onto a membrane via semi-dry transfer, and blocked with 5% non-fat milk for 2 hours. The membrane was incubated overnight at 4°C with primary antibodies (abcam) against CD9, CD63, and TSG101. After three 10-minute washes with TBST buffer, the membrane was incubated with secondary antibodies for 1 hour at room temperature. Following additional TBST washes, chemiluminescence detection was performed, and the results were imaged using a chemiluminescence system.

2.6. Cell Proliferation Assay

Uterine fibroblast cells were seeded in 96-well plates at a density of 1×10^4 cells per well. After cell adhesion, 100 µL of hUC-MSC-exo (10 µg/mL) or an equal volume of PBS (control) was added to each well. At 24, 48, and 72 hours post-treatment, 10 µL of CCK-8 reagent was added to each well, and the plates were incubated at

37°C in a 5% CO₂ incubator for 2 hours. The optical density (OD) at 450 nm was measured using a microplate reader to assess cell viability and proliferation.

2.7. Cell invasion assay

A Transwell invasion assay was used to evaluate the effect of hUC-MSC-exo on the invasive capacity of uterine fibroblast cells. hUC-MSC-exo (10 µg/mL) or an equal volume of PBS (control) was added to each well. Uterine fibroblast cells were resuspended in serum-free DMEM and seeded at a density of 5×10^4 cells per well in the upper chamber of a Transwell insert with an 8 µm pore size (Corning). The lower chamber was filled with 600 µL of DMEM containing 10% FBS as a chemoattractant. After 72 hours of incubation, the cells that invaded through the membrane were fixed with 4% paraformaldehyde for 20 minutes and stained with 0.1% crystal violet for 15 minutes. Cells on the upper side of the membrane were carefully removed, and the stained invasive cells were visualized and counted under a microscope.

2.8. Statistical analysis

All experiments were performed in triplicate, and data are presented as mean \pm standard deviation (SD). Statistical analysis was conducted using GraphPad Prism 7.0 software. Differences between groups were compared using a *t*-test, with a *P*-value of less than 0.05 considered statistically significant.

3. Results

3.1. Identification of hUC-MSC-exo

hUC-MSC-exo were successfully isolated using ultracentrifugation. Nanoparticle tracking analysis (NTA) confirmed the size distribution of the exosomes, showing an average diameter of approximately 130 nm (**Figure 1A**). The zeta potential measurement indicated a value of approximately -33 mV (**Figure 1B**), suggesting the stability of the exosomes in suspension. Transmission electron microscopy (TEM) revealed the morphology of the exosomes, showing a characteristic bilayer membrane structure with diameters ranging from 100 to 150 nm (**Figure 1C**). Furthermore, Western blot analysis demonstrated the clear expression of exosome-specific markers CD9, TSG101, and CD63 in the isolated samples, confirming the successful extraction of hUC-MSC-exo (**Figure 1D**).

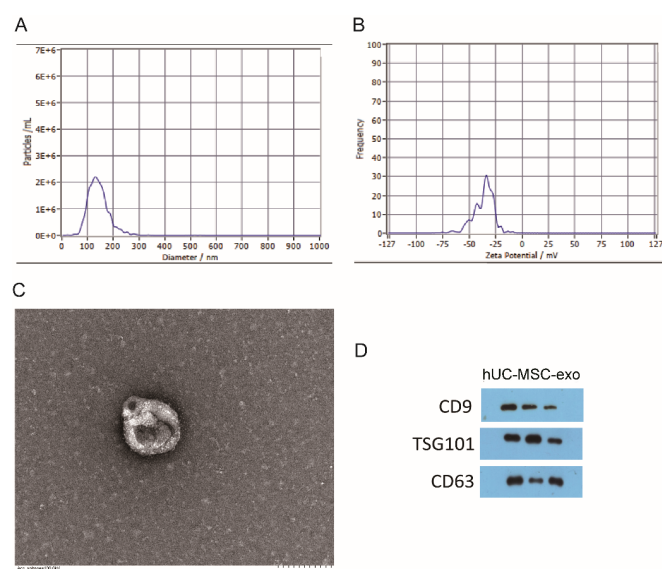


Figure 1. Identification of hUC-MSC-exo. **(A)** Particle size of hUC-MSC-exo. **(B)** The zeta potential value of hUC-MSC-exo. **(C)** Morphology of hUC-MSC-exo (scale bar = 200 nm). **(D)** Exosome-specific markers (CD9, TSG101, and CD63) of hUC-MSC-exo

3.2. hUC-MSC-exo inhibits uterine fibroblast cell proliferation

The effect of hUC-MSC-exo on uterine fibroblast cell proliferation was assessed using the CCK-8 assay. The results indicated that, compared to the Control group, where the optical density (OD) values for uterine fibroblast cells were 1.08 ± 0.06 , 1.42 ± 0.07 , and 1.80 ± 0.07 at 24, 48, and 72 hours respectively, the hUC-MSC-exo-treated group showed OD values of 0.90 ± 0.05 , 1.22 ± 0.08 , and 1.49 ± 0.07 at the same time points. This demonstrates a significant inhibition of cell proliferation in the hUC-MSC-exo group compared to the Control group. The reduction in cell proliferation was observed in a time-dependent manner, with statistical significance ($P < 0.05$) for all time points (**Figure 2**).

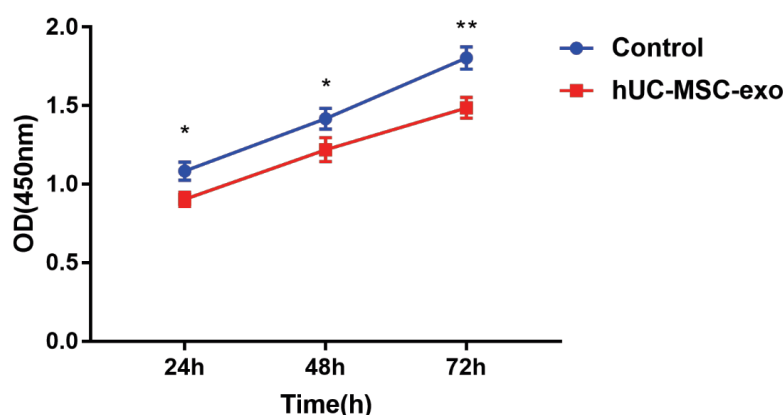


Figure 2. The effect of exosomes on the proliferation of uterine fibroblast cells was detected by CCK-8 assay. * $P < 0.05$, ** $P < 0.01$

3.3. hUC-MSC-exo inhibits uterine fibroblast cell invasion

The impact of hUC-MSC-exo on uterine fibroblast cell invasion was evaluated using the Transwell invasion assay. The results demonstrated a significant reduction in the number of cells that penetrated the Matrigel matrix in the hUC-MSC-exo-treated group compared to the Control group (**Figure 3**). This finding indicates that hUC-MSC-exo exerts a marked inhibitory effect on the invasive capability of uterine fibroblast cells.

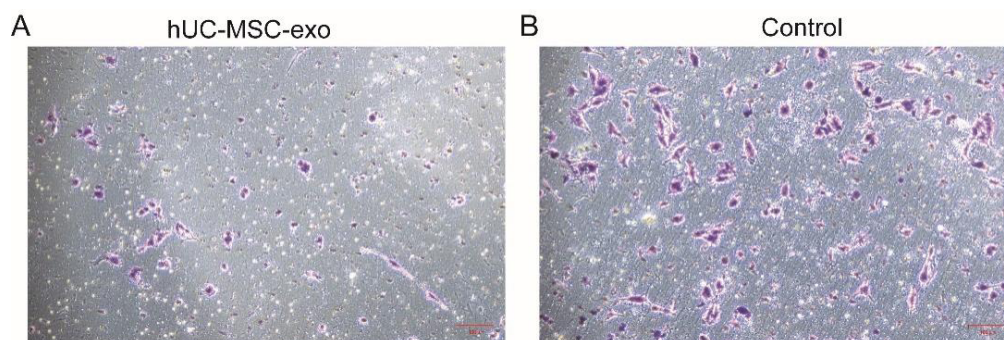


Figure 3. The effect of hUC-MSC-exo on the invasion ability of uterine fibroblast cells detected by Transwell assay. (A) The hUC-MSC-exo group; (B) Control group

4. Discussion

Recent advances in stem cell research have significantly impacted regenerative medicine and disease treatment. Human umbilical cord mesenchymal stem cells (hUC-MSC), known for their high proliferation capacity and multi-lineage differentiation potential, have garnered considerable attention ^[6,7]. hUC-MSCs not only show promising prospects in tissue repair and regeneration but are also widely used in clinical and basic research due to their abundant source and relatively non-invasive collection process ^[6,7]. Recent studies have revealed that hUC-MSCs play a crucial role in intercellular communication through the release of exosomes ^[11]. These exosomes are rich in biomolecules, such as proteins, lipids, and nucleic acids, which can modulate the physiological and pathological states of recipient cells, thereby influencing disease progression and tissue repair ^[12,13]. This study aimed to investigate the effects of exosomes derived from hUC-MSCs on the proliferation and invasion of uterine fibroblast cells. Our findings indicate that hUC-MSC-derived exosomes can significantly inhibit the proliferation and invasion of uterine fibroblast cells at certain concentrations, suggesting their potential therapeutic role in uterine scar repair and endometrial regeneration. This provides new insights into exploring uterine fibrosis and related diseases.

Uterine fibroblast cells, the principal stromal cells in uterine tissue, play a significant role in normal uterine function and pathological conditions such as a scarred uterus ^[14]. The aberrant proliferation of fibroblasts is often closely associated with the development of these pathological states. Our study demonstrates that the proliferation rate of uterine fibroblast cells treated with exosomes is significantly lower compared to the control group, indicating that exosomes derived from hUC-MSCs effectively inhibit the proliferation of uterine fibroblast cells. This highlights their potential in regulating cell proliferation. Exosomes may influence cell proliferation by releasing various bioactive molecules, such as proteins, miRNAs, and mRNAs, which affect the expression of cell cycle-related proteins. The inhibitory effect of hUC-MSC-exo on uterine fibroblast proliferation may involve multiple mechanisms. First, miRNAs within the exosomes are considered important regulators of cell proliferation. For example, miR-21 and miR-146a have been shown to inhibit the expression of cell cycle-related proteins, thereby slowing cell proliferation ^[15,16]. miR-21 directly affects the cell cycle by downregulating p53 target genes such as p21 and CDK4 ^[17], while miR-146a indirectly regulates the cell cycle and proliferation by inhibiting key components of the NF- κ B signaling pathway ^[18]. Additionally, protein factors within exosomes, such as transforming growth factor-beta (TGF- β) and interleukin-10 (IL-10), may also play critical roles. TGF- β inhibits cell cycle protein expression, preventing cells from entering the S phase and thus slowing proliferation ^[19], while IL-10 affects cell proliferation indirectly through immune and inflammatory responses ^[19]. These findings support our results and further confirm the multifaceted mechanisms of exosomes in cell proliferation regulation.

We further investigated the impact of hUC-MSC-exo on the invasion ability of uterine fibroblast cells using scratch assays. The results showed that the number of uterine fibroblast cells penetrating the membrane pores was significantly lower in the exosome-treated group compared to the control group, indicating that hUC-MSC-exo effectively inhibits the invasion ability of uterine fibroblast cells. Invasiveness is a key characteristic of uterine fibroblast cells in the progression of uterine diseases ^[14]. The mechanisms by which hUC-MSC-exo inhibits uterine fibroblast invasion may involve various bioactive molecules carried by the exosomes, including miRNAs, proteins, and lipids. These molecules regulate multiple signaling pathways that affect the adhesion, migration, and invasion of uterine fibroblast cells. Exosomes derived from mesenchymal stem cells have shown broad potential in inhibiting cell invasion. For example, miRNA-133b mediated by hUC-MSC-exo restricts

SGK1, promoting the proliferation, migration, and invasion of preeclampsia trophoblasts ^[20]. hUC-MSC-exo has also been shown to inhibit the proliferation, migration, and invasion of colorectal cancer cells through miR-3940-5p/miR-22-3p/miR-16-5p ^[21]. These studies provide theoretical support for our findings regarding the suppression of uterine fibroblast invasion by hUC-MSC-exo.

However, this study has some limitations. First, the experiments were conducted using in vitro cell models, and the actual effects of exosomes have yet to be validated in animal models or clinical patients. Second, although we examined some signaling pathways related to cell proliferation and invasion, other bioactive substances within the exosomes (such as miRNAs and proteins) may also be involved in the regulatory process, and these specific mechanisms need further investigation. Additionally, this study focused solely on the effects of exosomes on uterine fibroblast cells; future research should extend to other uterine-related cell types, such as endometrial epithelial cells and endothelial cells, to comprehensively evaluate the potential role of exosomes in uterine repair.

5. Conclusion

This study reveals that exosomes derived from hUC-MSCs significantly inhibit the proliferation and invasion of uterine fibroblast cells, providing a new perspective on the potential applications of exosomes in treating scarred uterine diseases. Future research will help further explore the mechanisms of exosome action and their clinical applications, offering new approaches and methods for treating scarred uterine conditions.

Funding

This study was supported by the Medical Research Project of Foshan Health Bureau (20220093), Project of Foshan Science and Technology (2220001003766), and Foshan Key Fields of Science and Technology (2020001005861).

Availability of data and materials

The datasets used and/or analyzed during the current study are available from the corresponding author upon reasonable request.

Authors' contributions

Conceptualization: Hai Tang, Zhengping Liu

Methodology: Hai Tang, Zhengping Liu

Formal analysis: Hai Tang, Xin Luo, Xiuyin Shen, Yingchun Wan

Investigation: Hai Tang, Xin Luo, Xiuyin Shen, Yingchun Wan

Writing – original draft: Hai Tang

Writing – review & editing: all authors

Disclosure statement

The authors declare no conflict of interest.

References

- [1] Carbonnel M, Pirtea P, de Ziegler D, et al., 2021, Uterine Factors in Recurrent Pregnancy Losses. *Fertil Steril*, 115(3): 538–545. <https://doi.org/10.1016/j.fertnstert.2020.12.003>
- [2] Murji A, Sanders AP, Monteiro I, et al., 2022, Cesarean Scar Defects and Abnormal Uterine Bleeding: A Systematic Review and Meta-Analysis. *Fertil Steril*, 118(4): 758–766. <https://doi.org/10.1016/j.fertnstert.2022.06.031>
- [3] Debras E, Capmas P, Maudot C, et al., 2024, Uterine Wound Healing After Caesarean Section: A Systematic Review. *Eur J Obstet Gynecol Reprod Biol*, 296: 83–90. <https://doi.org/10.1016/j.ejogrb.2024.02.045>
- [4] Xia W, Wang Q, Liu M, et al., 2023, Antifouling and Injectable Granular Hydrogel for the Prevention of Postoperative Intrauterine Adhesion. *ACS Appl Mater Interfaces*, 15(38): 44676–44688. <https://doi.org/10.1021/acsami.3c07846>
- [5] Morlando M, Conte A, Schiattarella A, 2023, Reproductive Outcome After Cesarean Scar Pregnancy. *Best Pract Res Clin Obstet Gynaecol*, 91: 102362. <https://doi.org/10.1016/j.bpobgyn.2023.102362>
- [6] Rodríguez-Eguren A, Gómez-Álvarez M, Francés-Herrero E, et al., 2022, Human Umbilical Cord-Based Therapeutics: Stem Cells and Blood Derivatives for Female Reproductive Medicine. *Int J Mol Sci*, 23(24): 15942. <https://doi.org/10.3390/ijms232415942>
- [7] Zhang J, Qu X, Li J, et al., 2022, Tissue Sheet Engineered Using Human Umbilical Cord-Derived Mesenchymal Stem Cells Improves Diabetic Wound Healing. *Int J Mol Sci*, 23(20): 12697. <https://doi.org/10.3390/ijms232012697>
- [8] Moroncini G, Paolini C, Orlando F, et al., 2018, Mesenchymal Stromal Cells From Human Umbilical Cord Prevent The Development of Lung Fibrosis in Immunocompetent Mice. *PLoS One*, 13(6): e0196048. <https://doi.org/10.1371/journal.pone.0196048>
- [9] Lin F, Chen W, Zhou J, et al., 2022, Mesenchymal Stem Cells Protect Against Ferroptosis via Exosome-Mediated Stabilization of SLC7A11 in Acute Liver Injury. *Cell Death Dis*, 13(3): 271. <https://doi.org/10.1038/s41419-022-04708-w>
- [10] Lin Y, Yan M, Bai Z, et al., 2022, Huc-MSC-Derived Exosomes Modified with The Targeting Peptide of aHSCs for Liver Fibrosis Therapy. *J Nanobiotechnology*, 20(1): 432. <https://doi.org/10.1186/s12951-022-01636-x>
- [11] Aliakbari F, Marzookian K, Parsafar S, et al., 2024, The Impact of hUC MSC-Derived Exosome-Nanoliposome Hybrids on α -Synuclein Fibrillation and Neurotoxicity. *Sci Adv*, 10(14): eadl3406. <https://doi.org/10.1126/sciadv.adl3406>
- [12] Hassanzadeh A, Shomali N, Kamrani A, et al., 2024, Detailed Role of Mesenchymal Stem Cell (MSC)-Derived Exosome Therapy in Cardiac Diseases. *EXCLI J*, 23: 401–420. <https://doi.org/10.17179/excli2023-6538>
- [13] Qian Z, Zhang X, Huang J, et al., 2024, ROS-Responsive MSC-Derived Exosome Mimetics Carrying MHY1485 Alleviate Renal Ischemia Reperfusion Injury through Multiple Mechanisms. *ACS Omega*, 9(23): 24853–24863. <https://doi.org/10.1021/acsomega.4c01624>
- [14] Muraoka A, Suzuki M, Hamaguchi T, et al., 2023, Fusobacterium Infection Facilitates The Development of Endometriosis Through The Phenotypic Transition of Endometrial Fibroblasts. *Sci Transl Med*, 15(700): eadd1531. <https://doi.org/10.1126/scitranslmed.add1531>
- [15] Wang K, Jiang Z, Webster KA, et al., 2017, Enhanced Cardioprotection by Human Endometrium Mesenchymal Stem

- Cells Driven by Exosomal MicroRNA-21. *Stem Cells Transl Med*, 6(1): 209–222. <https://doi.org/10.5966/sctm.2015-0386>
- [16] Ma G, Song G, Zou X, et al., 2019, Circulating Plasma MicroRNA Signature for The Diagnosis of Cervical Cancer. *Cancer Biomark*, 26(4): 491–500. <https://doi.org/10.3233/CBM-190256>
- [17] Yan H, Huang W, Rao J, et al., 2021, miR-21 Regulates Ischemic Neuronal Injury via The p53/Bcl-2/Bax Signaling Pathway. *Aging (Albany NY)*, 13(18): 22242–22255. <https://doi.org/10.18632/aging.203530>
- [18] Sun J, Liao Z, Li Z, et al., 2023, Down-Regulation miR-146a-5p in Schwann Cell-Derived Exosomes Induced Macrophage M1 Polarization by Impairing The Inhibition on TRAF6/NF- κ B Pathway After Peripheral Nerve Injury. *Exp Neurol*, 362: 114295. <https://doi.org/10.1016/j.expneurol.2022.114295>
- [19] Tovar Acero C, Ramírez-Montoya J, Velasco MC, et al., 2022, IL-4, IL-10, CCL2 and TGF- β as Potential Biomarkers for Severity in *Plasmodium vivax* Malaria. *PLoS Negl Trop Dis*, 16(9): e0010798. <https://doi.org/10.1371/journal.pntd.0010798>
- [20] Wang D, Na Q, Song GY, et al., 2020, Human Umbilical Cord Mesenchymal Stem Cell-Derived Exosome-Mediated Transfer of MicroRNA-133b Boosts Trophoblast Cell Proliferation, Migration and Invasion in Preeclampsia by Restricting SGK1. *Cell Cycle*, 19(15): 1869–1883. <https://doi.org/10.1080/15384101.2020.1769394>
- [21] Guo G, Tan Z, Liu Y, et al., 2022, The Therapeutic Potential of Stem Cell-Derived Exosomes in the Ulcerative Colitis and Colorectal Cancer. *Stem Cell Res Ther*, 13(1): 138. <https://doi.org/10.1186/s13287-022-02811-5>

Publisher's note

Bio-Byword Scientific Publishing remains neutral with regard to jurisdictional claims in published maps and institutional affiliations.

Research on Advances in Early Rehabilitation Intervention for Dysphagia

Sutao Si*

Affiliated Huishan Hospital of Xinglin College, Nantong University, Wuxi Huishan District People's Hospital, Wuxi 214000, Jiangsu Province, China

*Corresponding author: Sutao Si, 2789152487@qq.com

Copyright: © 2024 Author(s). This is an open-access article distributed under the terms of the Creative Commons Attribution License (CC BY 4.0), permitting distribution and reproduction in any medium, provided the original work is cited.

Abstract: Dysphagia is a common clinical symptom caused by various factors, significantly affecting patients' quality of life and prognosis. This paper aims to review recent advancements in early rehabilitation intervention for dysphagia, covering the significance of early rehabilitation, standards for functional assessment of dysphagia, timing for early rehabilitation training, psychological care, and rehabilitation training methods. The importance and latest research findings on early rehabilitation intervention for dysphagia are comprehensively discussed to provide a reference for clinical practice.

Keywords: Dysphagia; Early rehabilitation intervention; Psychological care; Rehabilitation training methods

Online publication: November 28, 2024

1. Introduction

Swallowing is a fundamental physiological function essential for human nutrition intake. However, many diseases, such as stroke, head and neck tumors, and neurodegenerative disorders, can lead to dysphagia. According to relevant data, the prevalence of dysphagia in stroke patients is approximately 50%–80%. If swallowing dysfunction occurs post-stroke, it significantly increases the risk of infections from various pathogens, malnutrition, pulmonary complications, and even death, often resulting in poor prognosis for patients^[1]. Rehabilitation training, as a form of therapeutic intervention, primarily aims to improve patients' motor functions by employing scientifically sound training methods to gradually enhance strength and flexibility, thus laying a solid foundation for recovery and helping patients return to normal life^[2]. Dysphagia not only exposes patients to risks like malnutrition and dehydration but also can lead to severe complications such as aspiration pneumonia, significantly increasing mortality and disability rates. Therefore, early rehabilitation intervention for dysphagia patients is crucial, as it can effectively improve swallowing function, enhance quality of life, reduce the incidence of complications, and promote overall patient recovery.

2. Significance of early rehabilitation intervention and standards for dysphagia functional assessment

2.1. Significance of early rehabilitation intervention

Symptoms associated with cerebral infarction are among the most common in cerebrovascular diseases. Statistics indicate that during the acute phase of cerebral infarction, the incidence rate can reach as high as 51%, with dysphagia having a significant impact on treatment outcomes throughout the patient's therapeutic process ^[3]. In their research, Wang ^[4] highlighted that it is essential to give adequate attention to cerebral infarction patients experiencing dysphagia. Implementing early rehabilitation training can effectively improve the swallowing function of these patients, helping them reduce the severity of their swallowing difficulties within a short time frame, potentially even achieving near-optimal recovery. This approach is effective because, in the early stages of dysphagia, while swallowing function is compromised, the nervous system retains a degree of plasticity. Early rehabilitation intervention leverages this plasticity through repeated stimulation and training to promote neural pathway reconstruction and functional recovery. Additionally, it can prevent complications from dysphagia, such as malnutrition, dehydration, and aspiration pneumonia, thus alleviating patient discomfort, reducing hospital stays, lowering medical costs, and improving satisfaction levels for both patients and their families.

2.2. Standards for dysphagia functional assessment

Accurately assessing the functional status of dysphagia patients forms the basis for designing a suitable rehabilitation plan. Currently, common clinical methods for assessing dysphagia function include:

- (1) Kubota Drinking Test: This test is simple and accessible. By observing patients as they drink water, including the time taken and any instances of choking, swallowing ability can be classified into different levels, providing a preliminary evaluation of the patient's swallowing function.
- (2) Videofluoroscopic Swallowing Study (VFSS): VFSS enables dynamic observation of structural and functional changes in areas such as the oral cavity, pharynx, and esophagus during swallowing, offering detailed insights into the specific location and mechanisms of dysphagia, thus providing precise guidance for rehabilitation training.
- (3) Fiberoptic Endoscopic Evaluation of Swallowing (FEES): FEES directly visualizes the mucosal surfaces of the pharynx and upper esophagus, evaluating pharyngeal sensation, motor function, and food residue during swallowing, making it valuable for detecting subtle swallowing difficulties.
- (4) Fujishima's 7-Point Dysphagia Scale: This scale integrates dysphagia symptoms with appropriate rehabilitation interventions, simplifying the assessment process and enabling precise, dynamic guidance on the patient's recovery progress in managing dysphagia ^[5].

3. Timing of early rehabilitation training intervention

Typically, as long as the patient's vital signs are stable, consciousness is clear, and the condition permits, rehabilitation training should be initiated as early as possible. For stroke patients, if there are no obvious contraindications such as severe cardiopulmonary insufficiency or coma, simple rehabilitation measures like oral muscle training can generally begin within 24–48 hours after onset. Research and practice on rehabilitation training suggest that the earlier rehabilitation training starts, the better the outcomes ^[6]. The first 24 hours post-

onset are regarded as the optimal time for combining active and passive functional training. Cai *et al.* ^[7] also found that systematic early rehabilitation training for cerebral infarction patients yields the best therapeutic results when swallowing treatment is initiated within 24 hours, given stable vital signs. Evaluation through the Kubota Drinking Test showed that the rehabilitation training group achieved significantly better outcomes than the control group (88% vs. 64%), not only reducing the degree of neurological impairment but also improving patients' quality of life and swallowing function ^[8]. These findings underscore the importance of determining the optimal timing for early rehabilitation training in dysphagia patients. However, the timing of early rehabilitation training cannot be universally applied and must account for individual differences. Some patients can start mild swallowing function training within a few days post-surgery, while those with more extensive surgical trauma and slower recovery may need to wait longer. Nevertheless, to maximize the nervous system's plasticity window, rehabilitation training should ideally begin within 1–2 weeks post-surgery.

4. Psychological care

Due to the difficulties associated with eating, dysphagia patients often experience anxiety, depression, and other negative emotions that hinder the rehabilitation process ^[3]. Stroke patients with dysphagia, in particular, may face various degrees of psychological disorders, further affecting mental health. Therefore, psychological interventions during rehabilitation training are essential ^[9]. Sun *et al.* ^[10] reported that combining rehabilitation nursing with psychological care for stroke patients with dysphagia can alleviate negative emotions, improve swallowing function, enhance quality of life, reduce psychological stress, and relieve negative feelings, thereby positively impacting mental health levels ^[11]. Additionally, studies indicate that 25%–73% of cerebral infarction patients develop negative emotions due to concerns about treatment outcomes, affecting their resilience ^[12]. Zhang ^[13] emphasized that timely adjustment of adverse psychological states and consistent psychological care facilitate rapid psychological recovery. Zhong *et al.* ^[14] advocated for strengthened communication between medical staff and patients, breaking down psychological misconceptions, encouraging patients to face their conditions positively, and fostering an optimistic outlook on life.

5. Rehabilitation training methods

5.1. Oral motor training

Oral motor training forms the fundamental basis for dysphagia rehabilitation, encompassing several targeted exercises. Localized exercises serve various functions: lip closure training involves guiding patients to repeatedly press and pucker their lips, enhancing lip muscle strength and closure capability to prevent food leakage; buccal muscle exercises, such as cheek puffing and sucking, help improve contraction and relaxation abilities, facilitating food manipulation within the oral cavity; and tongue exercises, like tongue protrusion, strengthen tongue muscles to aid in moving food to the pharynx. Overall, oral motor training focuses on stimulating the throat, pharyngeal, and oral muscles to prevent muscle atrophy and reduce the rehabilitation time for swallowing function. Repetitive swallowing and glottal closure exercises promote damaged nerve cell repair and central nervous system reorganization, accelerating swallowing recovery. Tongue exercises can also stimulate respiratory muscles, enhance pharyngeal pressure, improve coordination, and reduce complications ^[15]. Guo *et al.* ^[16] found that combining this training with psychological counseling benefits stroke patients

with swallowing dysfunction by improving swallowing function, nutritional status, and emotional well-being, thereby enhancing treatment effectiveness. Repeated training inputs into the brain facilitate the formation of new synaptic connections, improving central neuron plasticity, restoring motor reflexes, accelerating functional recovery, and ultimately enhancing swallowing ability^[17,18]. Zhu *et al.*^[11] reported that specialist nurse-led positive psychological interventions combined with oral motor training reduced anxiety and depression, improved swallowing function and nutritional indicators, and enhanced quality of life.

5.2. Swallowing function training

Swallowing function training improves microstructure and promotes motor cortex reconstruction through active and passive exercises of the lips and tongue muscles. Optimizing training methods and controlling training duration can also enhance patient compliance, supporting recovery^[19]. Zhang^[20] suggests pre-training mouth cleaning and honey massages for the mouth, tongue, and mucosa. Wang *et al.*^[21] recommend oral exercises such as opening and relaxing the mouth and moving the jaw from side to side, increasing speed gradually. Shao's^[22] research demonstrates that combining the Roy Adaptation Model with swallowing function training for elderly ACI patients with dysphagia can improve psychological and nutritional status, self-care abilities, and patient satisfaction. Xia *et al.*^[23] advocate for phonetic exercises, encouraging patients to produce monosyllabic sounds related to swallowing, thus promoting lip and associated muscle movement and closure functions.

5.3. Feeding training

Feeding training plays a critical role in improving swallowing function. By stimulating sensory and motor nerves associated with swallowing, this training enhances reflex flexibility, improves muscle coordination, and strengthens muscle power, effectively enhancing overall swallowing ability^[24]. Ensuring patient safety and training effectiveness is essential in feeding training, with quiet environments supporting relaxed nasal breathing, focus, and minimized aspiration risks^[25]. Moreover, guiding patients to focus on their eating helps them gauge appropriate speed and portion sizes, reducing dependency on others^[26]. Research supports these methods, as evidenced by Li *et al.*'s study^[27], which confirmed that direct feeding training combined with acupuncture and swallowing hydrogels significantly improves post-stroke swallowing function, enhancing quality of life. This approach effectively stimulates swallowing reflexes and improves patients' swallowing abilities.

5.4. Other rehabilitation training methods

In addition to the above methods, other suitable rehabilitation training approaches are chosen based on individual patient needs. Comprehensive, targeted training can improve the function of lips, jaw, tongue, airway closure, throat movement, and sensory input, thus holistically enhancing patients' feeding and swallowing capabilities.

- (1) Neck relaxation exercises: In addition to slow, routine head nodding, incorporate circular neck rotations—five times clockwise and counterclockwise, stretching muscles. Perform five repetitions per set for three sets, then pause to allow full neck relaxation.
- (2) Lip exercises: Instruct the patient to press their lips together while saying “en,” holding for five seconds and repeating ten times, then repeat with a smile. Similarly, say “wu,” extending the lips while pronouncing, and repeat five times. For lip resistance exercises, use a tongue depressor, tightly

close for eight seconds, then release; perform ten repetitions per set for three sets, gradually increasing resistance.

- (3) Jaw, facial, and cheek exercises: Move the jaw in each direction, holding for five seconds, repeating ten times, and pausing at the end range for three seconds. Puff the cheeks, apply finger resistance, and hold for five repetitions. Use a tongue depressor to stretch the affected cheek, adjusting strength as needed for 10 seconds per set, three sets total.
- (4) Tongue and soft palate exercises: After tongue protrusion exercises, add resistance movements to the tongue depressor, repeating five times. Lip-licking, with increased speed, should be completed within 10 seconds for three rounds.
- (5) Vocal fold closure and laryngeal elevation exercises: Instruct the patient to produce an “ah” sound, gradually raising the pitch and pausing to feel the vocal fold closure. Hold for three seconds, repeat ten times. For extended sounds, hold the “ah” for over five seconds, engaging the larynx, and repeat five times.
- (6) Breathing training: Beyond bubble and whistleblowing, add paper strip blowing exercises, placing a strip by the mouth and maintaining steady airflow to keep it suspended for 10 seconds, repeating five times.
- (7) Mendelsohn maneuver training: The therapist begins by gently massaging the neck and jaw, gradually increasing pressure. During swallowing, slight resistance is applied below the throat as appropriate, repeating five swallows per set for three sets.
- (8) Dry swallowing exercises: Encourage the patient to swallow as frequently as possible within a minute, aiming for 15 swallows initially, recording the count and progressively increasing the target.
- (9) Ice stimulation: Use an ice cotton swab to brush areas such as the back of the tongue, brushing each area for 15–20 seconds while monitoring reactions. Use moderate pressure and complete 2–3 rounds with rest intervals.

6. Conclusion and outlook

Early rehabilitation intervention for dysphagia is a multifaceted, comprehensive process involving the significance and evaluation criteria for early rehabilitation intervention, timing of intervention, psychological care, and various rehabilitation training methods. Accurate assessment of a patient’s swallowing function, timely intervention, enhanced psychological support, and the application of scientifically based rehabilitation methods, with adjustments to training intensity and frequency according to the patient’s condition, are crucial for improving swallowing function, enhancing the quality of life, and reducing complication rates. As medical research continues to advance, it is expected that future innovations in early rehabilitation interventions for dysphagia will provide more recovery prospects for patients.

Disclosure statement

The author declares no conflict of interest.

References

- [1] Mao L, Zhang R, Huang C, et al., 2021, Study on the Effect of Early Acupuncture Combined with Rehabilitation Training on Swallowing Function and Limb Function in Stroke Recovery Period. *Chinese Journal of Traditional Chinese Medicine*, 39(1): 241–244.
- [2] Chen J, Huang Y, Ou Y, et al., 2022, Effects of Neuromuscular Electrical Stimulation Combined with Swallowing Rehabilitation Training on Swallowing Function and Neurotrophic Factors in Elderly Patients with Neurogenic Dysphagia. *Chinese Journal of Gerontology*, 42(20): 5029–5032.
- [3] Duan H, Wang H, Li Y, 2015, Study on the Effect of Early Rehabilitation Nursing Intervention on Functional Recovery of Stroke Patients with Dysphagia. *Chinese Medical Innovation*, 12(8): 77–79.
- [4] Wang G, 2017, Analysis of the Effect of Early Rehabilitation Nursing Intervention on Dysphagia in Patients with Acute Stroke. *Inner Mongolia Medical Journal*, 49(9): 1143–1144.
- [5] Ju H, Su Y, Xue Y, 2014, Effect of Early Rehabilitation Nursing Intervention on Dysphagia Recovery in Stroke Patients. *Hunan Journal of Traditional Chinese Medicine*, 30(7): 129–130.
- [6] Yu G, Fu X, Ma R, et al., 2017, Evaluation of the Effect of Early Screening Assessment and Rehabilitation Nursing Intervention on Dysphagia in Cerebral Infarction. *Modern Medicine and Health*, 33(8): 1232–1234.
- [7] Cai W, Zhu Y, Huang Z, et al., 2010, Observation of the Efficacy of Early Rehabilitation Treatment for Dysphagia After Acute Cerebral Infarction. *Neural Injury and Functional Reconstruction*, 5(3): 185–188.
- [8] Liu F, 2017, Application of Early Rehabilitation Nursing Intervention in Functional Recovery of Stroke Patients with Dysphagia. *Chinese Medicine Guide*, 15(8): 266–267.
- [9] Luo Y, Jiang M, Yang H, 2019, The Relationship Between Perceived Social Support, Psychological Resilience, and Quality of Life in Stroke Patients with Dysphagia. *Chinese Journal of Practical Nursing*, 35(25): 1945–1951.
- [10] Sun H, Shi W, Han Y, 2020, Analysis of Rehabilitation Nursing and Psychological Nursing in Stroke Patients with Dysphagia. *Shanxi Medical Journal*, 49(6): 750–752.
- [11] Zhu Y, Huang X, Zhang W, et al., 2021, Effect of Positive Psychological Intervention Combined with Oral Motor Training on Swallowing Function, Nutrition, and Emotional Status in Patients with Acute Stroke. *Journal of Wannan Medical College*, 40(6): 592–595.
- [12] Meng D, Song W, 2016, Early Rehabilitation Nursing for Stroke Patients with Dysphagia. *Chinese Modern Doctor*, 54(13): 150–152.
- [13] Zhang S, 2016, Early Nursing Intervention for Patients with Progressive Cerebral Infarction and Dysphagia. *Massage and Rehabilitation Medicine*, 7(3): 89–90.
- [14] Zhong B, Lan Y, Zhu J, 2016, Effect of Early Systematic Swallowing Function Rehabilitation Training on Patients with Progressive Cerebral Infarction and Dysphagia. *Nursing Practice and Research*, 13(9): 148–149.
- [15] Luo W, Luo Y, Lin M, et al., 2021, Application of Visual Health Education Combined with Oral Motor Training in Stroke Patients with Dysphagia. *General Nursing*, 19(19): 2652–2655.
- [16] Guo Y, Guo Z, Tan S, et al., 2022, Application of Oral Motor Training Combined with Psychological Counseling in Stroke Patients with Dysphagia. *Journal of Integrative Nursing (Bilingual)*, 8(8): 70–72.
- [17] Zhu T, Fang Y, Xu J, et al., 2020, Effect of Psychological Intervention Based on the PERMA Model on Post-Traumatic Growth and Subjective Well-Being in Stroke Patients. *Journal of Nursing of the People's Liberation Army*, 37(6): 43–46.
- [18] Sun Y, Wu B, 2010, Enriching Rehabilitation Training and Neuroplasticity. *Chinese Journal of Rehabilitation Theory and Practice*, 16(7): 635–637.

- [19] Lai H, 2020, Application of Electrical Stimulation Combined with Resistance Exercise in Dysphagia After Cerebral Infarction. *Journal of Chronic Disease*, 2020(3): 465–467.
- [20] Zhang F, 2016, Observation of the Effect of Early Nursing Intervention in Patients with Progressive Cerebral Infarction and Dysphagia. *Heilongjiang Medical Journal*, 40(2): 181–182.
- [21] Wang M, Fu X, Jiang L, et al., 2017, Observation of the Effect of Early Rehabilitation Nursing Intervention on Elderly Patients with Cerebral Infarction and Dysphagia. *Chinese Clinical Nursing*, 9(3): 210–213.
- [22] Shao D, 2024, Analysis of the Effect of Roy Adaptation Model Combined with Swallowing Function Training on Elderly Patients with Acute Cerebral Infarction and Dysphagia in Recovery Period. *Journal of Chronic Disease*, 25(5): 759–762.
- [23] Xia S, Luo X, Li J, 2018, Effect Analysis of Early Rehabilitation Nursing Intervention on Elderly Patients with Cerebral Infarction and Dysphagia. *Journal of Taishan Medical College*, 39(6): 706–707.
- [24] Huang S, Xu J, Liu L, et al., 2021, Study on the Effect of Hydrogel Feeding Training on Improving Swallowing Function in Stroke Patients with Dysphagia. *Journal of Rehabilitation*, 31(5): 396–401.
- [25] Tang Q, Yuan X, 2014, Progress in Early Rehabilitation and Nursing of Cerebral Infarction. *Modern Medicine and Health*, 30(21): 3262–3263.
- [26] Peng S, Liu L, Pan D, 2017, Progress in Early Rehabilitation Nursing of Stroke Patients. *Journal of Integrated Nursing (Bilingual)*, 3(11): 7–11.
- [27] Li Y, Zhang S, Wang X, et al., 2024, Clinical Study of Tongue Acupuncture Combined with Hydrogel Direct Feeding Training in the Treatment of Dysphagia After Stroke. *Chinese Journal of Geriatric Health Care*, 22(4): 3–6.

Publisher's note

Bio-Byword Scientific Publishing remains neutral with regard to jurisdictional claims in published maps and institutional affiliations.

Effectiveness Evaluation of Need-Based Nursing for Hemodialysis Patients with Uremia

Jing Li*

Jilin Second Veterans Rehabilitation Hospital, Siping 136502, Jilin Province, China

*Corresponding author: Jing Li, 3374823545@qq.com

Copyright: © 2024 Author(s). This is an open-access article distributed under the terms of the Creative Commons Attribution License (CC BY 4.0), permitting distribution and reproduction in any medium, provided the original work is cited.

Abstract: *Objective:* To investigate the clinical effectiveness of need-based nursing interventions for hemodialysis patients with uremia. *Methods:* A double-blind, randomized controlled trial was conducted from January 2020 to June 2024, including a sample of 100 hemodialysis patients with uremia. The patients were randomly assigned into a test group ($n = 50$) and a control group ($n = 50$) using a random number table based on their medical record numbers. The control group received standard basic nursing care, while the test group received need-based nursing intervention. The two groups were compared based on self-care ability scores, resilience scores using the CD-RISC-10 scale, complication incidence rates, and nursing satisfaction. *Results:* After the nursing intervention, the test group showed significantly higher scores in self-care ability ($P < 0.05$) and CD-RISC-10 resilience ($P < 0.05$) than the control group. The incidence of complications was significantly lower ($P < 0.05$), and nursing satisfaction was notably higher ($P < 0.05$) in the test group compared to the control group. *Conclusion:* Need-based nursing for hemodialysis patients with uremia can enhance self-care abilities, improve psychological resilience, reduce complication rates, and increase nursing satisfaction, making it worthy of broader implementation.

Keywords: Uremia; Hemodialysis; Need-based nursing

Online publication: November 28, 2024

1. Introduction

Uremia represents the advanced stage of acute or chronic kidney failure, in which patients experience a severe decline in kidney function, disturbances in water and electrolyte balance, and retention of toxic substances and end metabolites in the body. This leads to multi-organ dysfunction, producing a range of symptoms and signs^[1]. Hemodialysis is the primary clinical treatment for uremia, purifying the blood, maintaining vital signs, and controlling disease progression. However, most patients with uremia lack an understanding of hemodialysis, often have negative emotions, and exhibit low adherence to the treatment process. To ensure the safety and efficacy of hemodialysis, comprehensive nursing interventions are essential. In conventional basic nursing, nurses focus on the fundamental operations of hemodialysis but pay insufficient attention to the patient's

physical and psychological state, resulting in suboptimal outcomes ^[2]. In contrast, need-based nursing involves assessing patient needs, formulating targeted care measures, and standardizing nursing operations, which can improve nursing quality ^[3]. This study included 100 hemodialysis patients with uremia to explore the clinical effectiveness of need-based nursing.

2. Materials and methods

2.1. General information

A double-blind, randomized controlled trial was conducted from January 2020 to June 2024, enrolling 100 hemodialysis patients with uremia. Patients were randomly assigned to either the test group ($n = 50$) or the control group ($n = 50$) based on their medical record numbers. The test group consisted of 28 males and 22 females, aged 51–68, with an average age of 59.72 ± 4.68 years and an average hemodialysis duration of 1.42 ± 0.38 years (range 6 months to 2 years). Underlying conditions included chronic glomerulonephritis (21 cases), diabetic nephropathy (19 cases), and other causes (10 cases). The control group had 27 males and 23 females, aged 53–67, with an average age of 59.66 ± 4.71 years and an average hemodialysis duration of 1.38 ± 0.45 years. Their underlying conditions included chronic glomerulonephritis (23 cases), diabetic nephropathy (18 cases), and other causes (9 cases). Baseline characteristics between the two groups were comparable ($P > 0.05$).

Inclusion criteria: (1) Diagnosed with uremia through comprehensive examination and assessment; (2) Receiving hemodialysis for over three months; (3) Signed informed consent.

Exclusion criteria: (1) Patients with hematological or infectious diseases; (2) Patients with malignant tumors; (3) Patients with incomplete clinical data or those who withdrew from the study mid-way.

2.2. Methods

The control group received standard basic nursing care. The nursing staff completed the routine setup of dialysis equipment parameters, observed the arteriovenous fistula, and performed standardized puncture operations. During hemodialysis, they closely monitored vital signs, assessed discomforts such as pain, and addressed abnormalities promptly. Following hemodialysis, staff provided brief explanations on daily care and answered patient questions.

The test group received need-based nursing intervention, outlined as follows:

- (1) Needs analysis: A hemodialysis care team was formed to review clinical data, communicate with patients and their families, and assess their knowledge, physical and mental state, and lifestyle. Care needs were determined, including health education, psychological support, and specialized dialysis care, with targeted nursing interventions developed accordingly ^[1-3].
- (2) Health education: Educational materials on uremia and hemodialysis were distributed to patients and families. Hemodialysis health videos were played in the ward, and the hospital's WeChat account was promoted for regular health knowledge updates. Staff provided in-person explanations about hemodialysis principles, its role in substituting renal function, balancing electrolytes, and the procedure for hemodialysis. They also answered patients' questions to foster an accurate understanding of hemodialysis.
- (3) Psychological nursing interventions: For patients exhibiting pessimism or depression, staff emphasized that hemodialysis minimally impacts daily life and effectively controls disease progression. Positive

outcomes from other cases were shared to reinforce hope for recovery. For anxious patients, calming techniques such as gentle touch, music, and breathing exercises were used, with reassurances on the low pain and high safety of hemodialysis procedures.

- (4) Vascular access care: For patients with arteriovenous fistulas, staff instructed them to elevate the affected limb post-surgery and advised against using that limb for blood draws, blood pressure monitoring, or carrying heavy objects. Patients were cautioned to avoid scratching the fistula area and to apply heat after dialysis, with fist exercises to improve blood circulation. For patients with venous catheters, antiseptic treatment of the catheter and surrounding skin was performed. If redness or oozing was observed around the catheter, iodine compression was applied or the catheter was removed. After dialysis, staff flushed the catheter with heparin and advised patients to avoid compressing the catheter area to maintain cleanliness and prevent dislodgement.
- (5) Puncture care: Before hemodialysis, nurses assessed fistula maturity, disinfected the skin and catheter, and chose a puncture site at least 5 cm from the anastomosis point. Dialysis parameters were set appropriately, and vital signs were monitored throughout the procedure. After dialysis, puncture sites were carefully compressed to control bleeding.
- (6) Dietary guidance: Patients were advised to eat small, frequent meals, reduce sugar, fat, and phosphorus intake, and supplement protein based on urine output to regulate food and water intake. Patients with less than 500 mL of daily urine were advised to limit potassium-rich foods (such as oranges, dates, and mushrooms). Those with hypoglycemia were encouraged to supplement with candies, while those with hypertension were advised to limit salt intake.
- (7) Complication management: Nurses closely monitored blood pressure, blood glucose, and sodium and water intake to ensure adequate and effective dialysis. Patients were encouraged to consume candy before dialysis, and hypoglycemic medication was reduced accordingly. Patients with hypertension followed prescribed medication routines to manage their blood pressure.

2.3. Evaluation indicators

- (1) Before and after nursing intervention, the Self-Care Ability Evaluation Scale was used to assess both groups. Evaluation items included self-concept, self-responsibility, self-care skills, and health knowledge level, with a positive scoring system.
- (2) The CD-RISC-10 Resilience Scale was used to assess psychological resilience in both groups before and after nursing intervention, evaluating optimism, self-strength, and resilience, with a positive scoring method.
- (3) Complication incidence rates were recorded for both groups.
- (4) Nursing satisfaction was assessed in both groups using a self-administered questionnaire.

2.4. Statistical analysis

Data analysis was performed using SPSS 23.0 software. Quantitative data (mean \pm standard deviation) were evaluated using *t*-tests, while categorical data [*n* (%)] were evaluated using χ^2 tests. A *P*-value of < 0.05 was considered statistically significant.

3. Results

3.1. Comparison of self-care ability scores

As shown in **Table 1**, post-intervention self-care ability scores were significantly higher in the test group compared to the control group ($P < 0.05$).

Table 1. Comparison of self-care ability scores before and after intervention (mean \pm SD)

Group	Self-concept		Self-responsibility		Self-care skills		Health knowledge level	
	Before	After	Before	After	Before	After	Before	After
Test ($n = 50$)	24.18 \pm 2.65	37.12 \pm 4.98	11.24 \pm 1.51	18.36 \pm 1.85	17.25 \pm 1.61	25.18 \pm 2.76	35.94 \pm 3.18	46.27 \pm 3.98
Control ($n = 50$)	24.26 \pm 2.59	32.45 \pm 2.79	11.18 \pm 1.47	14.22 \pm 1.17	17.19 \pm 1.65	20.12 \pm 1.29	36.02 \pm 3.25	42.75 \pm 1.84
<i>t</i> -value	0.153	5.785	0.201	13.374	0.184	11.744	0.124	5.677
<i>P</i> -value	0.879	0.000	0.841	0.000	0.854	0.000	0.901	0.000

3.2. Comparison of CD-RISC-10 scores

Table 2 shows that post-intervention CD-RISC-10 resilience scores were significantly higher in the test group compared to the control group ($P < 0.05$).

Table 2. Comparison of CD-RISC-10 scores before and after intervention (mean \pm SD)

Group	Resilience		Self-strength		Optimism	
	Before	After	Before	After	Before	After
Test ($n = 50$)	35.26 \pm 5.75	43.94 \pm 5.53	22.36 \pm 1.85	27.96 \pm 3.19	12.65 \pm 1.58	15.29 \pm 2.83
Control ($n = 50$)	35.18 \pm 5.82	38.75 \pm 2.64	22.41 \pm 1.92	23.81 \pm 2.08	12.71 \pm 1.64	13.72 \pm 1.77
<i>t</i> -value	0.069	5.989	0.133	7.706	0.186	3.326
<i>P</i> -value	0.945	0.000	0.895	0.000	0.853	0.001

3.3. Comparison of complication incidence rates

As shown in **Table 3**, the incidence of complications was significantly lower in the test group compared to the control group ($P < 0.05$).

Table 3. Comparison of complication incidence rates [n (%)]

Group	Hypertension	Hypotension	Hypoglycemia	Complication rate
Test ($n = 50$)	1	0	1	2 (4.0)
Control ($n = 50$)	3	3	2	8 (16.0)
χ^2 -value				4.000
<i>P</i> -value				0.045

3.4. Comparison of nursing satisfaction

Evaluation results indicated that nursing satisfaction in the test group (49/50) was 98.0%, significantly higher than that in the control group (41/50), which was 82.0% ($P < 0.05$).

4. Discussion

Uremia represents stages 4 and 5 of chronic kidney disease, during which patients experience endocrine dysfunction within the kidneys, electrolyte imbalances, and an inability to excrete toxic substances and metabolic by-products, leading to various symptoms and signs. Hemodialysis is the standard treatment for uremia; however, to reduce treatment risks and improve therapeutic outcomes, appropriate nursing interventions are required ^[4,5].

In standard basic hemodialysis nursing, fixed procedures such as observation and basic dialysis operations are employed, but there is insufficient focus on patients' cognitive levels and psychological issues, resulting in lower adherence to hemodialysis treatment and suboptimal physical and mental states during therapy ^[6]. The demand-driven nursing model, however, centers on the patient by analyzing and summarizing their specific nursing needs and subsequently formulating targeted nursing measures. This approach can enhance patients' awareness, improve their mental states, and ensure the safety and effectiveness of hemodialysis ^[7].

Results from this study indicate that the self-care ability scores in the experimental group were higher than those in the control group after nursing intervention, suggesting that demand-driven nursing can enhance patients' self-care abilities. Compared to the standard nursing protocol, the demand-driven model involves understanding patients' needs for hemodialysis-related health knowledge, formulating comprehensive health education plans, explaining the principles of hemodialysis, demonstrating methods for protecting vascular access, and highlighting lifestyle considerations. This enables patients to better understand the therapeutic effects of hemodialysis and increases their willingness and ability to engage in self-care ^[8]. In this study, CD-RISC-10 scores were also higher in the experimental group compared to the control group after nursing intervention, indicating that demand-driven nursing improves patients' emotional well-being. Through this model, caregivers embrace a humanistic approach, addressing patients' psychological issues, soothing negative emotions, and guiding family members to provide support, thereby reducing patients' negative emotional states ^[9]. Moreover, the experimental group had a lower incidence of complications than the control group, confirming that demand-driven nursing can reduce the occurrence of complications. By analyzing the causes of complications and implementing targeted preventive measures, caregivers can effectively lower complication rates. Lastly, nursing satisfaction in the experimental group was higher than that in the control group, as demand-driven nursing met the patients' specific care needs, significantly improving the standard and effectiveness of nursing operations, and thereby enhancing patient satisfaction ^[10].

5. Conclusion

In conclusion, demand-driven nursing in patients undergoing hemodialysis for uremia can improve self-care abilities, enhance psychological well-being, reduce complication rates, and increase nursing satisfaction, making it a valuable model for wider application.

Disclosure statement

The author declares no conflict of interest.

References

- [1] Li YP, Meng X, Hu JK, et al., 2024, Establishing and Applying A Quality-Sensitive Indicator System for Nutrition Screening and Assessment in Maintenance Hemodialysis Patients. *Nursing Research*, 38(14): 2582–2586.
- [2] Lin P, Wu XL, Chen SS, 2024, Observing the Effects of Micro-Video-Based Education and Specialized Workshops in Vascular Access Care for Maintenance Hemodialysis Patients. *Chinese Journal of Practical Nursing*, 40(8): 612–618.
- [3] Huang X, Yu XP, Liu YC, 2024, Application of Standardized Care Process Management Combined with A Humanistic Care Model in Hemodialysis for Uremic Patients. *Qilu Journal of Nursing*, 30(14): 115–117.
- [4] Gao LL, Wang JF, 2024, Application of An Incremental Exercise Intervention Program Based on Evidence-Based Nursing in Maintenance Hemodialysis Patients. *Evidence-Based Nursing*, 10(8): 1355–1359.
- [5] Shang YR, Hu XY, Guo JD, 2024, Effect of Continuous Nursing Intervention Based on A WeChat Platform on Maintenance Hemodialysis Patients. *Qilu Journal of Nursing*, 30(1): 62–65.
- [6] Wang WW, Wang HP, Zhang J, 2024, Application Effect of Individualized Exercise Therapy in Maintenance Hemodialysis Patients. *Chinese and Western Nursing (Bilingual)*, 10(5): 177–179.
- [7] Liu LX, Zhang J, Liu JX, et al., 2024, Constructing An Early Recognition and Care Process Management Plan for Catheter-Related Bloodstream Infections in Hemodialysis Based on Evidence. *Evidence-Based Nursing*, 10(3): 421–426.
- [8] Yu Y, Du AY, Zhao CM, et al., 2024, Application of Evidence-Based Supervision Nursing in Improving Management Levels of Diabetic Nephropathy Hemodialysis Patients. *International Journal of Nursing*, 43(8): 1401–1404.
- [9] Zhu DH, Ping MH, 2024, Impact of Progressive Target Nursing on Negative Emotions, Nutritional Status, and Self-Efficacy in Uremic Hemodialysis Patients. *International Journal of Nursing*, 43(17): 3125–3129.
- [10] Sun LM, Xu HL, Wang ZH, 2024, Effect of A High-Quality Targeted Nursing Model in Hypertensive Nephropathy Hemodialysis Patients. *International Journal of Nursing*, 43(10): 1784–1787.

Publisher's note

Bio-Byword Scientific Publishing remains neutral with regard to jurisdictional claims in published maps and institutional affiliations.

Clinical Characteristics and Prognostic Analysis of Hepatitis Complicated with Acute Pancreatitis

Jie Gao, Qiufeng He, Zhili Chen, Yang Deng, Li Wei, Qingfen Ye, Yu Xiao, Jing Peng, Ting Su, Chuangjie Mao*

Chengdu Public Health Clinical Medical Center, Chengdu 610000, Sichuan Province, China

*Corresponding author: Chuangjie Mao, sxwzgj@163.com

Copyright: © 2024 Author(s). This is an open-access article distributed under the terms of the Creative Commons Attribution License (CC BY 4.0), permitting distribution and reproduction in any medium, provided the original work is cited.

Abstract: *Objective:* To explore the clinical characteristics and prognostic risk factors of patients with hepatitis complicated by acute pancreatitis, aiming to provide insights for early clinical intervention. *Methods:* Clinical data from patients diagnosed with hepatitis complicated by acute pancreatitis and acute pancreatitis alone, admitted to our hospital from January 2017 to December 2023, were collected. General information, symptoms, laboratory results, imaging findings, and prognostic outcomes were analyzed and compared between the two groups. Statistical analyses included *t*-tests, Mann-Whitney U tests, χ^2 tests, univariate regression, and multivariate binary logistic regression to identify independent prognostic risk factors. *Results:* A total of 109 patients were included: 53 with hepatitis complicated by acute pancreatitis and 56 with acute pancreatitis alone. The hepatitis-complicated group had significantly longer hospital stays and lower levels of blood amylase, lipase, PTA%, and PLT, while TBil was higher compared to the acute pancreatitis group ($P < 0.05$). The positive rates of ultrasound, CT, and MRI in detecting complications showed no significant differences between the two groups. Among hepatitis-complicated cases, viral hepatitis was the most common cause (52.8%), and liver failure was the most common clinical type (49.1%). Univariate analysis identified factors such as liver failure, NEUT%, and REC as risk factors for poor prognosis. Multivariate logistic regression showed that liver failure, NEUT%, and REC were independent prognostic risk factors ($P < 0.05$). *Conclusion:* Hepatitis can complicate acute pancreatitis, with viral hepatitis and liver failure being the most common. Symptoms are non-specific, often including fatigue and digestive discomfort. Early diagnostic tests, especially abdominal imaging, are essential for accurate diagnosis. Prognosis is influenced by the degree of liver damage, with liver failure, NEUT%, and REC being key independent risk factors.

Keywords: Hepatitis; Acute pancreatitis; Clinical characteristics; Prognosis; Risk factors

Online publication: November 28, 2024

1. Introduction

Liver inflammation refers to inflammatory changes in the liver caused by viral infections, drugs, metabolic