· Case ·

Nursing care and infection management of a patient with sinusoidal obstruction syndrome after allogeneic hematopoietic stem cell transplantation under immunosuppression: a case report

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Abstract

This report summarizes the nursing and infection management process for a patient who developed severe late-onset sinusoidal obstruction syndrome while in a state of deep immunosuppression after allogeneic hematopoietic stem cell transplantation. Key nursing measures included: strict adherence to infection control protocols in the laminar airflow ward during potent immunosuppressive therapy; rigorous aseptic techniques for invasive procedures such as abdominal paracentesis and drainage to prevent catheter-related infections; and enhanced monitoring and differentiation of symptoms like fever and diarrhea to guard against opportunistic infections. Symptom management for sinusoidal obstruction syndrome, nutritional support, and psychological care were implemented concurrently. Through these comprehensive nursing interventions, the patient recovered without developing any severe infections while immunocompromised. This case offers valuable insights into infection prevention and comprehensive care for similar high-risk patients.

Keywords: hematopoietic stem cell transplantation, sinusoidal obstruction syndrome, infection control, immunosuppression, nursing care

Hepatic sinusoidal obstruction syndrome (SOS) is a life-threatening severe complication following hematopoietic stem cell transplantation (HSCT). Its pathological core is toxic damage to hepatic sinusoidal endothelial cells and hepatocytes caused by the conditioning regimen (such as cyclophosphamide or Busulfan), which subsequently leads to hepatic venular obstruction, intrahepatic portal hypertension, and a series of clinical syndromes [1]. Allo-

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geneic HSCT patients are already in a deep and prolonged immunodeficient state due to conditioning-induced marrow suppression and routine use of immunosuppressants (such as calcineurin inhibitors or anti-thymocyte globulin) to prevent graft-versus-host disease (GVHD). This makes them among the highest-risk groups for hospital-acquired infections [2]. When these patients develop SOS, particularly severe delayed-onset SOS, there are two challenges to their clinical management. First, standard treatment of SOS often requires the addition of potent immunosuppressants such as corticosteroids to control excessive inflammatory responses [3]. Second, the massive ascites and liver failure caused by SOS often require invasive procedures such as abdominal puncture drainage and deep venous catheterization [4]. The combination of these two factors leads to an exponential increase in the risk of infection, with a significant rise in the probability of opportunistic pathogen infections (such as bacteria, fungi, and viruses), severely threatening the patient's survival [5]. The scope of nursing work for these patients goes far beyond conventional SOS symptom management. It requires the construction and execution of a comprehensive, multi-layered infection prevention and control system, while actively treating the primary complications. The effectiveness of this system directly affects the patient's prognosis [6]. This article provides a detailed report of the nursing practice used for a patient who developed severe delayed-onset SOS after allogeneic hematopoietic stem cell transplantation. It describes how resources were integrated and precise strategies implemented under conditions of deep immunosuppression, as an example of achieving a unified approach for effective infection prevention and successful management of complications.

Clinical Data

General Information

The patient, a 28-year-old male, visited the hospital in October 2023 because of bilateral neck masses accompanied by pruritus and night sweats. A biopsy of the left neck mass revealed a pathological diagnosis of anaplastic large cell lymphoma, ALK-positive (stage III B). After receiving four cycles of the ECHOP regimen, the patient was assessed as partially responding. He received a combination of selinexor and ECHOP for the fifth and sixth cycles, with assessment still showing partial remission. The patient chose autologous stem cell transplantation, undergoing stem cell mobilization and peripheral blood stem cell collection after the seventh cycle of the ECHOP regimen. He then underwent lumbar puncture with intrathecal chemotherapy and received brentuximab vedotin (CD30-targeted) combined with the GemOx regimen for the eighth and ninth cycles of consolidation chemotherapy. Disease evaluation indicated progression, and thus crizotinib + ICE + brentuximab vedotin was used for the tenth cycle of chemotherapy. The patient was scheduled for sibling full-matched allogeneic hematopoietic stem cell transplantation and was transferred to the sterile laminar flow room on July 7, 2024. Before transplantation, the patient had normal liver function and no history of hepatitis. Infection prevention and control during the immunocompromised period became one of the main nursing challenges.

The conditioning regimen used was a myeloablative protocol (Busulfan + Fludarabine + Cytarabine), with ursodeoxycholic acid, low molecular weight heparin, and prostaglandin E1 administered to prevent SOS. Cyclosporine + cyclophosphamide + anti-human thymocyte immunoglobulin + mycophenolate mofetil were used to prevent GVHD. Acyclovir was administered to prevent viral infections, and intravenous immunoglobulin was infused to enhance immune function. The patient received an infusion of sibling-matched type B hematopoietic stem cells on July 14 and 15 (CD34+ 3.23×10^6/kg, mononuclear cells 13.8×10^8/kg). Neutrophil engraftment occurred on day 19 post-transplant, and platelet engraftment was delayed until day 51

post-transplant. The patient was discharged from the laminar flow room on August 8.

On day 25 post-transplant (August 10), the patient developed abdominal distension, right upper abdominal tenderness, and reduced urine output, followed by complaints of pain in the liver area. Abdominal ultrasound revealed ascites (daily ascites volume from August 12 to 26 ranged from 1,080 to 3,100 mL, with an average of 1,466 mL). Laboratory tests showed significant increases in transaminases, bilirubin, and creatinine: ALT (Alanine Aminotransferase) peaked at 1,459 U/L, aspartate aminotransferase (AST) at 1,648 U/L, total bilirubin at 3.485 mg/dl, and serum creatinine at 164.6 μmol/L, more than twice the baseline value (<70 μmol/L) before transplantation. Based on these clinical presentations and laboratory findings, the condition was diagnosed as severe delayed-onset SOS on day 25 post-transplant. Cyclosporine was immediately discontinued, and defibrotide and methylprednisolone (potent immunosuppressants) were used to treat the SOS, along with measures to protect the liver, albumin infusion, pain relief, diuretics, and fibrinogen supplementation. Two weeks later, the patient's liver function gradually returned to normal (Table 1).

Diagnosis and Outcome

The process of diagnosis followed the recommendations of the Chinese Society of Hematology expert consensus (2022 edition) [7], and used the SOS diagnostic criteria proposed by the European Society for Bone Marrow Transplantation (EBMT) [8]. For classic SOS, these are: bilirubin > 2 mg/dl within 21 days post-HSCT, along with at least two of the following symptoms: painful hepatomegaly, weight gain ≥ 5%, and ascites. For delayed-onset SOS, the criteria are: classic SOS or pathologically confirmed SOS occurring more than 21 days post-HSCT, or at least two classic criteria with accompanying ultrasound or hemodynamic evidence. The grading criteria for SOS from the American Society of Hematology [9] were used (Table 2).

Nursing practices

Hierarchical nursing for systemic infection prevention and control

The patient underwent myeloablative conditioning and administration of anti-human thymocyte immunoglobulin and cyclosporine, and received methylprednisolone during SOS treatment. They were therefore in a deep and complex immunosuppressive state. We implemented a systematic infection control strategy based on laminar flow rooms.

Environmental and barrier isolation

The patient was treated in a class 100 sterile laminar flow

Table 1. Nursing key points and corresponding outcome timeline.

Time relative to HSCT	Key events/nursing interventions	Outcome/patient status
Day 7	Transferred to a sterile laminar flow room	High-level environmental isolation initiated
Day 14–15	Infusion of hematopoietic stem cells	Transplantation completed
Day 19	Neutrophil engraftment	Hematopoiesis begins to recover
Day 25	Abdominal distension, liver area pain, diagnosed as severe delayed-onset SOS	Initiation of SOS-specific treatment and care
Day 25–40	Discontinuation of cyclosporine; initiation of defibrotide + methylprednisolone; abdominal puncture drainage; implementation of three-dimensional infection control system	SOS condition controlled; no severe infections occurred during this period
Around day 40	Liver function gradually returns to normal, ascites resolves	Clinical recovery from SOS
Day 51	Platelet engraftment	Full recovery of hematopoietic function
Discharge	Transfer from the laminar flow room	Condition stable, no severe infections

Notes: HSCT: hematopoietic stem cell transplantation, SOS: sinusoidal obstruction syndrome.

Table 2. Diagnosis, grading, and outcome in this case.

Postoperative SOS Occurrence Time (Days)	Clinical Manifestations of SOS							SOS Grading	Prognosis
	Hepatomegaly1	Liver Area Pain	ALT (U)	AST (U)	Total Bilirubin (mg/dl)	Serum Creatinine (umol/L)	Ascites2		
Day 25	+	+	1459	1648	3.485	164.6	++	Severe3	Recovered

Notes: 1. The abdominal ultrasound of the patient in this case showed the anteroposterior diameter of the right liver to be 16.3 cm (normal range: 12–14 cm), indicating hepatomegaly.
2. Ascites > 1000 mL: "++".
3. Using the American Society of Hematology SOS grading criteria, the patient's transaminase levels were more than five times the upper limit for normal, and serum creatinine was more than twice the baseline value (pre-transplant serum creatinine was less than 70 umol/L). The patient's SOS was therefore classified as severe.
Abbreviations: ALT, alanine aminotransferase; AST, aspartate aminotransferase; SOS, sinusoidal obstruction syndrome.

room during the peri-transplantation period. After being transferred to the hematology ward on day 23, strict protective isolation measures were continued throughout the treatment of delayed-onset SOS. Strict management protocols for the laminar flow room were followed, with daily disinfection of environmental surfaces and objects. Medical staff strictly followed hygiene protocols, including handwashing and putting on sterile isolation gowns, masks, and gloves before entering the room. All items brought into the room were disinfected to minimize the introduction of exogenous infection sources.

Infection prevention and control for invasive procedures

The patient underwent abdominal puncture drainage to treat massive ascites, with a drainage tube remaining for 15 days. This procedure is a high-risk factor for hospital-acquired infections, particularly abdominal infections and catheter-related bloodstream infections. Nursing measures included:

(1) Strict adherence to sterile technique during catheter insertion and maintenance, with transparent dressings being changed twice weekly at the puncture site, and monitoring for redness, swelling, heat, pain, and exudation;

(2) Maintaining a closed drainage system, performing sterile procedures when changing the drainage bag to prevent retrograde air flow; and

(3) Daily assessment of whether the drainage tube was still required to avoid unnecessary retention.

By using these measures, no puncture site or abdominal infection occurred during the drainage period.

Symptom monitoring and infection differentiation

Infection symptoms in immunosuppressed patients are often atypical. Nursing care requires high vigilance to differentiate between symptoms of SOS (such as fever and diarrhea) and those caused by infections. For fever management, nurses were required to closely monitor temperature changes, promptly notify the physician if fever occurred, and follow medical orders to collect blood, ascitic fluid, and other specimens for microbial culture before using antibiotics. For diarrhea, they were required to accurately record the frequency, nature, and volume of diarrhea, distinguish between increased ascites from SOS and intestinal GVHD or infectious diarrhea, and promptly send stool samples for routine examination and culture.

Specialized symptom management for SOS

Ascites and abdominal drainage nursing

The patient's ascites persisted for 15 days, with daily drainage volumes ranging from 1,080 to 3,100 mL, with an average of 1,466 mL. The ascites was yellow or light red in color. Daily monitoring of weight, abdominal cir-

cumference, and input/output volumes was performed. The patient was assisted to assume a semi-recumbent or sitting position, with foam dressings applied to pressure areas, and regular repositioning was carried out. Oxygen was administered to alleviate respiratory distress. Enhanced abdominal skin care was provided, and sterile, loose cotton clothing was changed daily. During the maintenance of the abdominal drainage, the catheter was properly secured, and the puncture site was monitored for signs of bleeding, exudation, redness, swelling, and subcutaneous emphysema. Drainage speed was controlled to avoid rapid drainage, which could lead to hypotension or hypoalbuminemia. The drainage bag was changed daily to prevent air from entering the abdominal cavity.

Nursing for therapeutic medications

The focus was on observing the potential side effects of defibrotide, such as hypotension and tendency to bleed. Special attention was given to the secondary infection risks associated with methylprednisolone. We provided enhanced care for the oral cavity, respiratory tract, and perineum, closely monitoring for early signs of infection such as coughing, sputum production, and sore throat.

Nutritional support, pain, and psychological care

Nutritional and dietary care: The patient's appetite decreased because of the abdominal distension and pain. Based on liver function, enteral and parenteral nutritional support was provided under the guidance of the nutrition department. When abdominal distension was significant, foods that produce gas, such as sweet potatoes, soy products, and milk, were avoided. The abnormal liver function and ascites caused protein loss, and thus high-quality proteins, high-calorie, light, and easily digestible foods were provided. Water and sodium intake were restricted, and small, frequent meals were recommended.

Nursing for other symptoms: 1) Pain management: The patient's pain in the liver area was rated from 2–7 on the Numeric Rating Scale (NRS). Non-pharmacological pain relief measures, such as psychological counseling, were provided. When the pain score was > 4, fentanyl transdermal patches or tramadol injections were used for pain relief under the direction of a physician. The fentanyl transdermal patches were applied to a hairless, smooth area of the torso or upper arm, with the dosage adjusted based on pain severity. The patch was changed every 72 hours, and the application site rotated during each change. 2) Psychological care: Studies show that transplant patients are prone to psychological distress during their stay in the laminar flow room, with the highest incidence of psychological problems occurring between conditioning and cell engraftment. The patient's self-reported depression score (SDS) ranged from 45 to 65 during transplantation and SOS, indicating mild to moderate depression. Nurses assessed the patient's psychological state daily, encouraged the patient to express their feelings, and assisted family members to provide emotional support through video calls, encouragement cards, and other means, helping to build the patient's confidence during treatment.

Discussion

Hepatic sinusoidal obstruction syndrome (SOS) after allogeneic hematopoietic stem cell transplantation is a major clinical challenge, and the complexity of its nursing care goes beyond the scope of supporting a single organ function. It is a comprehensive management issue involving multiple systems and aspects [9]. This case shows that building a comprehensive nursing system for these patients, centered on infection prevention and control, enables successful treatment.

The cumulative effect of immunosuppressive states and escalated risk

The uniqueness of this case lies in the fact that the patient's immunosuppressive state was not caused by a

single factor but resulted from a triple overlap of myeloablative conditioning, immunosuppressants to prevent GVHD and corticosteroid treatment for SOS [10]. The use of methylprednisolone to control the inflammatory response in SOS played a therapeutic role but also further weakened the patient's cellular immune function, creating an in vivo environment conducive to the proliferation and invasion of opportunistic pathogens such as fungi, viruses, and bacteria [11]. This clinical paradox of treating one disease while potentially causing others requires nursing care to be both forward-looking and holistic. The success of this case hinged on the nursing team's proactive identification of this risk escalation. They did not simply view the use of methylprednisolone as a routine medical order but as a trigger for initiating higher-level infection monitoring, providing dynamic enhancement of nursing care levels [12].

Core elements of a three-dimensional infection prevention and control network

The three-dimensional infection prevention and control network built in this case can be broken down into three key aspects, each playing a crucial role in blocking the infection. The first aspect was environmental and barrier control. The class 100 laminar flow room acted as a physical barrier to effectively cut off the transmission route of exogenous infection sources. It is therefore the primary defense for protecting patients during the immunocompromised period. Its value lies in both the equipment itself and in the strictly enforced protocols for personnel and item management, which serve as the first gate of infection prevention [13].

The second aspect was the closed-loop management of invasive procedures. The abdominal drainage tube, as a potential infection pathway connecting the outside environment to the body cavity, is pivotal in the success or failure of infection control. In this case, catheter-related infections were successfully prevented through strict sterile catheter placement and maintenance, close observation of the puncture site, and maintaining a closed drainage system [14]. This confirms that for any procedure that disrupts the skin/mucosal barrier, it is essential to apply sterile principles to every detail to minimize infection risks. This approach can be extended to the management of other invasive devices, such as central venous catheters and urinary catheters [15].

Table 3. Key points of three-dimensional infection prevention and control nursing measures [7].

Prevention level	Core nursing measures	Specific key points and basis
Environmental and barrier isolation	Class 100 laminar flow room management	1. Strictly implement environmental disinfection protocols. 2. Medical staff must strictly follow hand hygiene practices before entering the room, and wear sterile isolation gowns, masks, and gloves. 3. All items entering the room must be disinfected to cut off exogenous infection sources.
Invasive procedure management	Abdominal drainage tube care	1. Strictly adhere to sterile techniques for catheter placement and maintenance. 2. Regularly replace puncture site dressings and closely monitor for signs of infection. 3. Keep the drainage system closed to prevent retrograde infections. 4. Assess whether the drainage tube remains essential each day, to facilitate early removal.
Proactive symptom monitoring	Differentiating infection symptoms	1. Monitor temperature closely, and if fever occurs, promptly collect blood, ascitic fluid, and other specimens for culture before using antibiotics. 2. Carefully record diarrhea characteristics, differentiate between SOS/GVHD/infectious diarrhea, and send stool samples promptly for culture.
Special immunosuppressive monitoring	Monitoring drug-related infection risks	1. Focus on the risk of opportunistic infections caused by methylprednisolone. 2. Strengthen care for the oral cavity, respiratory tract, and perineum. 3. Closely monitor for early infection signs such as coughing and sputum production.

Notes: GVHD, graft-versus-host disease; SOS, sinusoidal obstruction syndrome.

The final area was proactive symptom monitoring and early warning. In a state of deep immunosuppression, the differential diagnosis of the causes of symptoms such as fever and diarrhea is particularly challenging. A highlight of the nursing care in this case was that these symptoms were not simply attributed to SOS or GVHD. Instead, constant vigilance was maintained for infection. Samples were actively collected and sent for testing, providing key evidence for early and accurate microbiological diagnosis. This symptom-oriented, proactive differentiation monitoring model is the key to achieving early detection, early diagnosis, and early treatment of infections [16].

Implications for clinical nursing practice

The nursing practice in this case provides important insights for managing similar high-risk patients. First, it clearly suggests that the nursing team must adopt an integrative thinking approach with a dual-front strategy. The first front must focus on specialized care for SOS itself, including meticulous fluid management, liver function monitoring, ascites drainage, and pain control [17]. The second front maintains a lifeline throughout by focusing on comprehensive infection management because of iatrogenic immunosuppression [18]. These two fronts are interdependent and mutually influential components of a unified strategy. The stabilization of SOS provides time to control infections, and successful infection prevention creates the foundation for SOS recovery.

In summary, for patients with SOS after allogeneic HSCT, the essence of nursing lies in shifting from the traditional "complication response" model to an approach that anticipates risk and provides a systematic defense [19]. By constructing and strictly implementing a three-dimensional infection prevention and control network integrating environmental isolation, invasive procedure management, and proactive symptom monitoring, the significant risks associated with immunosuppression can be effectively managed. This provides the strongest and most reliable safeguard to enable the patient to safely navigate the critical period and recover.

Future nursing practice should further strengthen this integrative nursing philosophy and explore more structured risk assessment tools and intervention strategies to continually improve the prognosis of patients like this [20].

Acknowledgements

We would like to extend our heartfelt appreciation to Mr. Li Wang from the Chongqing Medical and Pharmaceutical College for their invaluable contributions to the data collection and experimental process. Their meticulous efforts ensured the accuracy and reliability of our research findings. Additionally, we are grateful to Mr. Lvsu Ye from the First Affiliated Hospital of Chongqing Medical and Pharmaceutical College for their assistance in data analysis and interpretation, which greatly enhanced the depth and quality of our research outcomes.

Author Contributions

L. Wang, L. Zhang, Z.J. Xi, Q.Q. Liu, C. Liu, J.M. Jiang, Y.M. Wu, M. Yu, Y.S. Liu and X.B. Li contributed to the writing of the original draft and the preparation of figures. X.B. Li provided writing review and editing, and supervision. All authors contributed to the article and approved the submitted version.

Funding

The authors declare that financial support was received for the research, authorship, and publication of this article. This work was funded by Chongqing medical scientific research project (Joint project of Chongqing Health Commission and Science and Technology Bureau) (No. 2023GGXM006), 2025 Natural Science Foundation of

Chongqing (No. CSTB2025NSCO-GPX1116), 2024 Scientific research project of Chongqing Medical and Pharmaceutical College (No. ygzrc2024101), Chongqing Education Commission Natural Science Foundation (No. KJQN202402821 and No. KJQN202502819), and 2024 Chongqing Medical and Pharmaceutical College Innovation Research Group Project (No. ygz2024401), and Chongqing Science and Health Joint Medical Research Project (No. 2024SQKWLHMS051).

Conflict of interests

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Data Availability Statement

The original contributions presented in the study are included in the article. Further inquiries can be directed to the corresponding author.

Ethics Approval and Consent to Participate

This study was conducted following the ethical guidelines outlined in the Declaration of Helsinki. Ethical approval was obtained from the Institutional Review Board (IRB) of Chongqing Medical and Pharmaceutical College, with approval number KYLLSC20240730015. All procedures involving human participants were performed in compliance with the institutional and national research committees' ethical standards. Informed consent was obtained from the participant in this study based on the Declaration of Helsinki.

Patient Consent for Publication

Written informed consent for the publication of any identifiable patient data (including images, case details, and personal information) was obtained from the participant of this study. The patient was informed about the study's purpose and agreed to the publication of their anonymized data for research purposes.

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