American Journal of
Biomedical Science & Research

www.biomedgrid.com
ISSN: 2642-1747

Case Study

Refined Postoperative Nursing in an Adolescent Undergoing Heart Transplantation for DSC2/TAB2 Cardiomyopathy

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To Cite This Article: *Li Xinrui*, Deng Chengming, Li Yan, Tang Fuping and Tu Huiqiong. Refined Postoperative Nursing in an Adolescent Undergoing Heart Transplantation for DSC2/TAB2 Cardiomyopathy. Am J Biomed Sci & Res. 2025 28(5) AJBSR.MS.ID.003723,* **DOI:** 10.34297/AJBSR.2025.28.003723

Received: September 30, 2025; **Published:** October 13, 2025

Abstract

Aim: To summarize the refined postoperative nursing experience of an adolescent with end-stage heart failure caused by DSC2/TAB2 gene mutation who underwent orthotopic heart transplantation, with a focus on analyzing the key nursing points and strategies during the critical postoperative intensive care period, in order to provide a reference for the clinical care of similar complex cases.

Design: This study is a retrospective case analysis.

Methods: A series of personalized and precise nursing interventions were implemented for the patient. These included precise postoperative monitoring (close monitoring of hemodynamics and graft heart function), meticulous immunosuppressive care (timed administration, concentration monitoring, observation for adverse reactions), systematic infection prevention and control, prophylactic care for bleeding and thrombosis, as well as step-by-step rehabilitation nursing and psychological support.

Results: Through the aforementioned refined nursing, the patient's vital signs remained stable after surgery. No serious complications such as acute rejection, severe infection, bleeding, or thrombosis occurred. The recovery process was smooth, with the patient transferred from the cardiothoracic surgical ICU on the 10th postoperative day and discharged on the 22nd postoperative day.

Conclusion: For adolescent patients with complex genetic disorders undergoing heart transplantation, the implementation of systematic and individualized, refined nursing care during the postoperative critical period is key to ensuring surgical success, preventing complications, and promoting smooth recovery.

Impact: This report elaborates on the core nursing strategies for the postoperative care of such high-risk patients, which can provide practical guidance for clinical nurses managing similar complex cases, highlighting the important value of precision nursing in improving surgical success rates and patient outcomes.

Patient or Public Contribution: No patient or public contribution was involved in this study as it is a retrospective case report.

Keywords: DSC2/TAB2 gene; Cardiomyopathy; Heart Transplantation; Adolescent; Child; Nursing

Introduction and Background

Dilated cardiomyopathy (DCM) is a primary myocardial disease characterized by ventricular dilation and impaired myocardial contractile function. Its pathological manifestations include cardiomyocyte degeneration, fibrosis, and abnormal expression of contractile proteins, ultimately leading to progressive arrhythmias, heart failure, sudden death, and thromboembolism [1-2]. Epidemiological data indicate that the global prevalence of DCM ranges from 0.25% to 0.4%. In China, the estimated prevalence is approximately 1 in 625, with 72.1% of hospitalized cardiomyopathy patients presenting with concomitant heart failure. Among these,

about 5%-10% are adolescent patients, often associated with gene mutations such as abnormalities in the DSC2/TAB2 genes. The five-year survival rate for such patients is less than 50% [3-6]. Heart transplantation, the surgical procedure of implanting a heart from a brain-dead, immunologically matched donor into a recipient's thoracic cavity, has become increasingly performed with advances in medical technology in China. Currently, over 700 heart transplantations are performed annually in the country [7-9]. As a definitive treatment for end-stage DCM, heart transplantation significantly improves prognosis, with international registry data reporting a one-year survival rate of up to 90%. However, the procedure entails significant challenges, including maintaining hemodynamic stability, preventing acute rejection, controlling severe infections, and ensuring the precise application of immunosuppressants to manage multiple potential complications [8]. In May 2025, our center admitted an adolescent patient with cardiomyopathy caused by DSC2/TAB2 gene mutations who underwent heart transplantation. Through the implementation of a series of individualized and refined nursing interventions, the patient's vital signs remained stable without major complications. The patient was transferred from the cardiothoracic surgical intensive care unit on postoperative day 10 and was discharged successfully on day 22. This report aims to provide a detailed analysis of the key nursing considerations and strategies during the critical postoperative intensive care period, intending to serve as a valuable reference for the clinical nursing management of similar complex cases.

Clinical Data

General Information

The patient was a 15-year-old male of Uyghur ethnicity. In October 2023, he presented to a hospital in Xinjiang with cough. During auscultation, faint heart sounds were noted. Further work-up included a chest X-ray revealing cardiomegaly and an echocardiogram suggesting tricuspid valve dysplasia?/possible right ventricular non-compaction and severe tricuspid insufficiency. Genetic testing confirmed dual mutations in the DSC2/TAB2 genes (associated with Arrhythmogenic Right Ventricular Cardiomyopathy Type 2 and Congenital Heart Disease Type 2). Subsequently, he was hospitalized multiple times due to acute exacerbation of chronic cardiac insufficiency (NYHA class IV) accompanied by multiple organ failure (including acute liver failure, severe pneumonia, and coagulopathy). Management included supportive therapies such as anti-infection treatment, potassium/sodium/calcium supplementation, myocardial nutrition, hepatoprotection, albumin infusion, coagulation function improvement, fluid restriction, and stabilization of the internal environment. To seek surgical intervention, he was admitted to our hospital on May 23, 2025, with the diagnoses of "Cardiomyopathy, Heart Failure."On admission: Temperature: 36.6°C, Pulse: 62 beats/min, Respiratory Rate: 20 breaths/min, Blood Pressure: 90/51 mmHg. He was conscious with a general condition, without eyelid edema or cyanosis of the lips. No jugular vein distention was observed. Breathing was平稳 (steady), with a regular rhythm; coarse breath sounds were heard bilaterally without rales. A systolic rumbling murmur was audible over the tricuspid area, and a systolic ejection murmur was heard over the mitral area. Echocardiography showed a right atrial thrombus and a small pericardial effusion.Laboratory findings included: High-sensitivity troponin: 20.500 ng/mL (elevated); Myoglobin: 24.2 ng/mL (low); Pro-B-type Natriuretic Peptide (ProBNP): 2719.00 pg/mL (elevated); Plasma Prothrombin Time: 16.60 s (elevated); INR: 1.39; Plasma D-dimer: 0.73 mg/L (elevated); Gamma-glutamyl transferase: 202 U/L (elevated); Hemoglobin: 102 g/L; Hematocrit: 32.8% (low); Blood type identification: Rh(D) positive, Type B.Quantitative color Doppler echocardiography demonstrated significant enlargement of the right atrium and ventricle, diffuse hypokinesis of the right ventricular wall, severe tricuspid and pulmonary valve insufficiency, and mild mitral valve insufficiency. Right ventricular systolic function was significantly reduced, while left ventricular systolic function was slightly reduced.

Treatment and Outcome

As the patient's cardiac function indices continued to deteriorate, a multidisciplinary team consultation concluded that he had end-stage heart failure and was indicated for heart transplantation. After completing preoperative evaluations, the patient underwent orthotopic heart transplantation under general anesthesia on May 25, 2025. The procedure involved heparinization, establishment of cardiopulmonary bypass (CPB), and hypothermia. Intraoperative findings included a right atrial mural thrombus (2 cm in diameter) and 200 ml of light-yellow pericardial effusion. After thorough thrombus removal, the left atrium, aorta, and pulmonary artery were anastomosed continuously using 4-0 polypropylene sutures. The heart resumed spontaneous sinus rhythm (78 beats/min) upon aortic unclamping. The total operative time was 4 hours and 55 minutes. Transesophageal echocardiography confirmed normal valve function and cardiac performance within normal range. The patient was successfully weaned from CPB after a total bypass time of 295 minutes. Pericardial and mediastinal drainage tubes, along with a pulmonary artery (Swan-Ganz) catheter, were placed intraoperatively. The patient was transferred to the Cardiothoracic and Vascular Surgical Intensive Care Unit (CVS ICU) on vasoactive and sedative drug support.Postoperative management included mechanical ventilatory support, continuous ECG and blood pressure monitoring, strict intake/output measurement, and pharmacotherapy per protocol. Medications encompassed: Anti-heart failure agents (Sacubitril/Valsartan tablets, recombinant human B-type natriuretic peptide); Immunosuppressants (Tacrolimus capsules, Mycophenolate Mofetil capsules, Methylprednisolone sodium succinate for injection, Prednisone acetate tablets); Anti-infectives (Cefoperazone/Sulbactam sodium for injection, Ganciclovir dispersible tablets for cytomegalovirus prophylaxis); Acid-suppression/Gastroprotective agent (Omeprazole sodium); Sedative-hypnotic/Anxiolytic (Alprazolam tablets); Diuretics (Furosemide injection, Torasemide injection); and agents for correcting fluid-electrolyte and acid-base imbalances plus nutritional support (Sodium bicarbonate injection, Concentrated sodium chloride injection, Potassium chloride injection/sustained-release tablets). Anemia was corrected with transfusions of Type B plasma and Type B leuko-

cyte-depleted red blood cells.Through standardized medical treatment and nursing care, the patient's endotracheal tube, pulmonary artery catheter, and nasogastric tube were successfully removed on postoperative day (POD) 1. The pericardial/mediastinal drains and urinary catheter were removed on POD 7. The patient was transferred from the CVS ICU to the general pediatric ward on POD 10 and was discharged home on POD 22. This study was approved by the Hospital Ethics Committee (Approval No. KY2025-129). Informed consent was obtained from all participants.

Nursing Management

Precision Postoperative Monitoring to Prevent Complications

Rigorous Hemodynamic Monitoring and Management to Maintain Graft Function Stability: The first 48-72 hours post-heart transplantation represent the period of greatest hemodynamic instability, fraught with risks such as graft dysfunction, arrhythmias, and vasomotor dysregulation [11]. Studies indicate that elevated pre-operative pulmonary artery systolic pressure is an independent risk factor for post-transplant right heart failure [12]. The nursing goal was to maintain adequate cardiac output and tissue perfusion. 1). Continuous Multi-Parameter Monitoring: Invasive arterial and pulmonary artery (Swan-Ganz) catheters were used for continuous hemodynamic monitoring. Key parameters included Central Venous Pressure (CVP), Pulmonary Artery systolic pressure (PASP), Pulmonary Capillary Wedge Pressure (PCWP), Cardiac Output (CO), Cardiac Index (CI), Systemic Vascular Resistance Index (SVRI), and Pulmonary Vascular Resistance Index (PVRI). Daily transthoracic echocardiography (TTE) assessed Left Ventricular Ejection Fraction (LVEF). Based on literature recommendations [13], target values were maintained: Mean Arterial Pressure (MAP) > 65 mmHg, CVP 8-12 mmHg to ensure right heart preload, CI > 2.5 $L \cdot min^{-1} \cdot m^{-2}$ for tissue perfusion, urine output > 1 $ml \cdot kg^{-1} \cdot h^{-1}$, and serum lactate trending down and maintained at < 2 mmol/L. Nurses recorded and assessed trends in these parameters hourly. Pericardial and mediastinal chest tubes were stripped every 15 minutes for the first 0-2 hours postoperatively to ensure patency. Drainage volume, color, and character were documented; output >100 mL/h for 2 consecutive hours warranted immediate physician notification. Postoperative pericardial drainage was typically 50-100 ml, and mediastinal drainage 20-50 ml, appearing as light red serosanguinous fluid. 2). Precision Goal-Directed Fluid Management: Given the patient's pre-existing fluid overload from severe heart failure and the risk of tissue edema from capillary leak syndrome postoperatively, strict adherence to a "output-guided input" or even "negative fluid balance" principle was maintained initially. More precise volume indicators like CVP, Intrathoracic Blood Volume (ITBV), and Extravascular Lung Water (EVLW) guided fluid replacement and diuretic (Furosemide) use to avoid volume overload stressing the new heart and lungs. 3). Fine-Tuning of Vasoactive and Inotropic Agents: Vasoactive (e.g., Isoprenaline) and inotropic drugs (e.g., Milrinone, Levosimendan) were administered via infusion pumps as prescribed. Nurses meticulously titrated the doses within the prescribed ranges based on real-time MAP, CI, and SVRI to achieve hemodynamic goals at the lowest effective dose, while closely monitoring for adverse effects. 4). Arrhythmia Monitoring: The denervated donor heart typically exhibits a basal heart rate of 75-95 bpm. Continuous ECG monitoring focused on detecting atrial arrhythmias and junctional rhythms. Four hours after ICU admission, frequent ventricular premature contractions occurred, which resolved with intravenous Lidocaine per protocol. A temporary pacemaker and emergency medications were kept at bedside.

Respiratory Support and Weaning Management to Ensure Gas Exchange and Prevent Pulmonary Complications: The patient's history of severe pneumonia and the risk of ventilator-associated pneumonia (VAP) necessitated early liberation from invasive mechanical ventilation [14]. 1). Sedation and Analgesia Management: Upon ICU admission, deep sedation was maintained with Remifentanil and Midazolam infusions to mitigate stress, assessed every 2-4 hours using the Critical-Care Pain Observation Tool (CPOT, target 0-3) and Ramsay Sedation Scale (target -2 to -3). Sedatives were stopped after extubation on postoperative day (POD) 2. During early mobilization, the patient reported incisional pain (Numeric Rating Scale score 3), managed with a Butorphanol infusion. Anxiety and insomnia due to separation from family were addressed with oral Alprazolam and complementary therapy involving auricular acupressure at Shenmen, Subcortex, Heart, and Kidney points by a specialized nurse [15]. 2). Strict Airway Management Protocol: This included bilateral breath sounds auscultation every 2 hours, endotracheal tube cuff pressure monitoring (maintained at 25-30 cmH_2O) every 4 hours, regular turning, percussion, and nebulization. Humidification was adjusted based on sputum viscosity. A VAP prevention bundle was implemented: head-of-bed elevation 30°-45°, rigorous oral care, suctioning only as needed with pre-oxygenation (100% FiO_2 for 2 minutes) [16]. Muscle relaxants were considered post-suctioning to control pulmonary artery pressure spikes induced by stimulation. 3). Systematic Weaning and Extubation: On POD 2, the patient met spontaneous breathing trial (SBT) criteria: hemodynamic stability on minimal vasoactive support, good oxygenation (PaO_2/FiO_2 > 200 mmHg), stable metabolic status, alert mental state, and effective cough. Following successful SBT, the endotracheal tube was removed, transitioning to mask oxygen. Arterial blood gases and respiratory function were closely monitored thereafter. Chest CT on POD 10 showed near-complete resolution of minor left lung inflammation.

Precision Immunosuppressive Management: Preventing acute rejection is paramount post-transplant but requires potent immunosuppression, balancing risks of infection and drug toxicity [17]. The patient received triple-drug therapy: Methylprednisolone, Tacrolimus (Tac), and Mycophenolate Mofetil (MMF). 1). Drug Level Monitoring and Observation: Nurses, as the final executors of the regimen, adhered to a precise medication schedule. During intravenous Methylprednisolone pulse therapy, blood pressure, blood glucose, and psychiatric symptoms were closely monitored. Due to Tac's narrow therapeutic window and inter-individual variability, pre-dose (trough) blood levels were meticulously checked. Target Tac trough levels are typically 10-15 ng/mL in the first month post-transplant [18-19]. On POD 4, the patient's Tac level was el-

evated at 15.20 ng/mL. Nurses alerted the physician for dose adjustment while monitoring for neurotoxicity (tremors, headache) or nephrotoxicity (changes in creatinine, urine output). Elevated renal artery resistance index, Urea (23.82 mmol/L), Creatinine (216 μmol/L), and Uric Acid (704 μmol/L) prompted aggressive hydration, diuresis with Furosemide, and readiness for renal replacement therapy. By POD 10, the Tac level stabilized around 10.78 ng/mL. 2). Early Recognition of Acute Rejection: Nurses act as sentinels for rejection, vigilantly monitoring for non-specific signs like low-grade fever, malaise, palpitations, or unexplained weight gain. They also watched for new arrhythmias or decreased QRS voltage on telemetry and reported any echocardiographic signs suggestive of rejection (e.g., wall thickening, diastolic dysfunction) promptly to facilitate early diagnosis (e.g., via endomyocardial biopsy) and intervention [20-21]. This patient exhibited no signs of acute rejection.

Systematic Infection Prevention and Control: Building Multi-Layer Protective Barriers: The profoundly immunosuppressed state predisposes the patient to bacterial, fungal, and viral infections. Care followed Chinese guidelines for managing post-heart transplant complications (2019) [22]. 1). Environmental and Contact Isolation: The patient was housed in a laminar airflow room under strict protective isolation. The ICU environment was disinfected with 3% hydrogen peroxide vaporizers; bed units were ozonated; surfaces and bed units were wiped twice daily with 1000 mg/L chlorine-containing solution; items were disinfected with wipes containing 1% hydrogen peroxide. Visitor access was restricted, with strict hand hygiene, gowning, and masking enforced. 2). Invasive Catheter Management: Central venous, arterial, and urinary catheters were managed using bundle care strategies. Daily assessment for necessity, site care, and inspection for signs of infection (redness, exudate) were performed. 3). Administration and Monitoring of Prophylactic Antimicrobials: Antibiotics (Cefoperazone-Sulbactam) and antivirals (Ganciclovir for CMV prophylaxis) were administered punctually. Nurses monitored for adverse effects like bone marrow suppression. 4). Vigilant Monitoring for Infection Signs: Daily monitoring included temperature, complete blood count (WBC, neutrophils), C-reactive protein (CRP), and procalcitonin (PCT). Close observation of wounds, drainage characteristics, and respiratory secretions was maintained. Any abnormality prompted immediate specimen collection for culture. The patient experienced no major hemorrhage or cardiac tamponade. The Swan-Ganz catheter was removed on POD 2, and chest tubes were removed on POD 7 when drainage was <10 ml, with a chest X-ray confirming minimal pleural fluid.

Management of Coagulopathy and Thromboprophylaxis: Pre-existing coagulopathy and the intraoperative right atrial thrombus identified this patient as high-risk for thrombosis. Early postoperative management involved daily coagulation profiles (PT, aPTT, INR) and D-dimer monitoring. Nurses observed for bleeding tendencies (petechiae, ecchymosis, changes in drainage, persistent oozing at puncture sites). Anticoagulation was initiated per protocol once bleeding risk was deemed acceptable. Early mobilization with passive limb exercises and intermittent pneumatic compression devices for the lower limbs was implemented. After drain removal on POD 7, the patient was encouraged and assisted with ambulation. Nurses assessed both lower limbs every 2 hours for signs of deep vein thrombosis (DVT) - swelling, pain, warmth - and remained alert for symptoms of pulmonary embolism (PE). The patient developed no DVT or PE during hospitalization.

Psychological Care for the Patient and Family

The patient, a 15-year-old adolescent, was at a developmental stage characterized by both dependency and a quest for independence. Awakening after a major trauma, his psychological resilience was fragile, with an extreme need for security. The absence of parents triggered profound separation anxiety, manifesting as confusion, intense nervousness, distrust of the environment, and resistance to medical procedures. A primary nurse was assigned as a "surrogate parent" and consistent communicator, providing continuous presence and emotional support. Communication was gentle, patient, and used age-appropriate language to explain procedures, respecting his autonomy and reducing fear of the unknown. The room was personalized with comforting decorations and his personal items (e.g., phone, books) as his condition improved. A multidisciplinary team, including a Uyghur translator, created an illustrated health handbook for children/adolescents. It covered transplant knowledge, treatment, and featured an "Emotion Diary" section and Q&A area, encouraging expression of feelings and questions through writing/drawing, which nurses reviewed daily. To alleviate separation anxiety, a remote video visitation system was set up for daily scheduled calls with his parents, providing visual reassurance and emotional comfort. At discharge, the patient wrote a thank-you note in both Chinese and Uyghur.

Rehabilitation and Discharge Planning

Early rehabilitation is crucial for improving activity tolerance, reducing complications, enhancing cardiopulmonary function, and improving prognosis. A multidisciplinary team (cardiothoracic surgery, pulmonology, radiology, cardiac rehabilitation, pediatrics) devised a gradual cardiac rehab plan based on hemodynamics, tolerance, and functional status. 1). POD 1-3 (During mechanical ventilation): With patient sedated and muscle strength grade 1-2, therapists performed passive limb movements, 20 minutes/session, twice daily. 2). POD 4-5: Bedside sitting was introduced, gradually increasing the backrest elevation from 30° to 60°, 20 minutes/session, twice daily. 3). POD 6-11: Ankle pump exercises and progressive resistance lower limb training were initiated (30 minutes/session, twice daily). As tolerated, the patient progressed to sitting at the bedside, standing with support, and marching in place (10 minutes/session, twice daily), with constant therapist supervision for safety.After transfer to the pediatric ward, the focus shifted to reinforcing rehabilitation, self-management education, and discharge readiness.Medication Adherence Education: Repeated, systematic education for the patient and family emphasized the lifelong necessity of immunosuppressants, covering drug names, actions, doses, timing, and side effects. Illustrated medication cards were provided.Self-Monitoring Guidance: Training was given on daily monitoring and recording of weight, temperature, blood pres-

sure, and heart rate, with clear instructions on when to seek medical help (e.g., weight gain >1 kg/24h, temperature >38°C).Lifestyle and Infection Prevention Advice: Guidance included personal hygiene, maintaining a clean/ventilated home environment, avoiding crowds, avoiding contact with pets/ill individuals, and food safety. Nutritional Support: After extubation and nasogastric tube removal on POD 2, the patient progressed to a low-salt, low-fat, balanced oral diet under a dietitian's guidance.

Summary

The perioperative nursing management for this 15-year-old with DCM due to DSC2/TAB2 mutations involved significant challenges, including risks of early right heart failure, pulmonary hypertension, acute kidney injury, and immunosuppressant toxicity. The successful outcome stemmed from close multidisciplinary collaboration and, crucially, highlighted the core value of refined, evidence-based nursing. Through precise hemodynamic management, rigorous immunosuppressive monitoring, comprehensive infection prevention, early rehabilitation, and family-involved education, the nursing team effectively prevented and managed potential complications, playing a vital role in enhancing graft success and patient survival.

Conflicts of Interest

All authors declare no conflicts of interest.

Author Contributions Statement

Li Xinrui: Implementation of case-based care, case collection, and paper writing;

Deng Chengming: Implementation of care, case collection;

Li Yan: Guidance on case-based care measures, financial support;

Tang Fuping, Tu Huiqiong: Guidance on case-based care measures, content review, and paper revision.

Ethics Statement

This study was approved by the Ethics Committee of The People's Hospital of Guangxi Zhuang Autonomous Region (Approval No. KY2025-129). Informed consent was obtained from all participants.

Conflicts of Interest

The authors declare no conflicts of interest.

References

1. Mahmaljy H, Yelamanchili VS, Singhal M (2023) Dilated Cardiomyopathy. In: StatPearls. Treasure Island (FL): StatPearls Publishing.
2. (2018) Chinese Society of Cardiology, Chinese Cooperative Group on Myocarditis and Cardiomyopathy. Chinese guideline for diagnosis and treatment of dilated cardiomyopathy. J Clin Cardiol 34(5): 421-434.
3. Ahmed H, Vanderpluym C (2021) Medical management of pediatric heart failure. Cardiovasc Diagn Ther 11(1): 323-335.
4. Reichart D, Magnussen C, Zeller T, S Blankenberg (2019) Dilated cardiomyopathy: from epidemiologic to genetic phenotypes: a translational review of current literature. J Intern Med 286(4): 362-372.
5. Chinese Society of Cardiology, et al. (2025) Chinese comprehensive guideline for the management of cardiomyopathy (2025). Chin Circ J 40(5): 420-462.
6. Yin H, Guo X, Chen Y, Yachang Zeng 1, Xiaoliang Mo, et al. (2022) TAB2 deficiency induces dilated cardiomyopathy by promoting RIPK1-dependent apoptosis and necroptosis. J Clin Invest 132(4): e152297.
7. (2023) National Center for Infectious Diseases, Chinese Society of Organ Transplantation, Committee of Organ Transplantation Rehabilitation of Chinese Association of Rehabilitation Medicine, et al. Expert consensus on diagnosis and treatment of SARS-CoV-2 infection in solid organ transplant recipients (2023). Organ Transplant 14(2): 163-182.
8. Kitagaki K, Ono R, Shimada Y, Hidetoshi Yanagi, Harumi Konishi, et al. (2021) Cardiac rehabilitation program improves exercise capacity in heart transplantation recipients regardless of marginal donor factors. Heart Vessels 36(5): 659-666.
9. Shi B (2019) The development status of organ transplantation in China: A report at the 2018 Annual Meeting of the Chinese Society of Organ Transplantation. Organ Transplant 10(1): 32-35.
10. Wang X (2014) How high is the success rate of heart transplantation?. Beijing Science and Technology News.
11. Kędziora A, Piątek J, Hymczak H, Grzegorz Wasilewski, Bartłomiej Guzik, et al. (2021) Early postoperative hemodynamic instability after heart transplantation - incidence and metabolic indicators. BMC Anesthesiol 21(1): 236.
12. Chen Y, Guo C, Zhang J, et al. (2025) Risk assessment of right heart failure after heart transplantation based on preoperative pulmonary artery pressure. Tianjin Med J 53(7): 751-755.
13. Rivers E, Nguyen B, Havstad S, J Ressler, A Muzzin, et al. (2001) Early goal-directed therapy in the treatment of severe sepsis and septic shock. N Engl J Med 345(19): 1368-1377.
14. Kózka M, Sega A, Wojnar-Gruszka K, Agnieszka Tarnawska, Agnieszka Gniadek, et al. (2020) Risk Factors of Pneumonia Associated with Mechanical Ventilation. Int J Environ Res Public Health 17(2): 656.
15. Li X, Zhou X, Huang J, et al. (2025) Effect of five-element music therapy combined with umbilical moxibustion on sleep and inflammatory factors in patients with post-stroke depression of liver-qi stagnation type. J Nurses Train 40(12):1285-1290.
16. Klompas M, Branson R, Cawcutt K, Matthew Crist, Eric C Eichenwald, et al. (2022) Strategies to prevent ventilator-associated pneumonia, ventilator-associated events, and nonventilator hospital-acquired pneumonia in acute-care hospitals: 2022 Update. Infect Control Hosp Epidemiol 43(6): 687-713.
17. Zhu J, Wu M (2025) Review of Chinese literature on heart transplantation in 2024. Organ Transplant 16(3): 368-378.
18. You J, Chen R, Chai Y, Xue Wang, Wenmin Xie, et al. (2025) Comparing tacrolimus level monitoring in peripheral blood mononuclear cells and whole blood within one year after kidney transplantation: a single-center, prospective, observational study. Front Pharmacol 16: 1622702.
19. Griffis OL, Thai SQ, Allison C, Cody Allison, Brooke Baetz, et al. (2022) The Association Between Tacrolimus Levels and Hyperkalemia in Allograft Recipients Who Underwent Heart or Lung Transplantation in New Orleans, USA Between 2013 and 2019: A Single-Center Retrospective Study. Ann Transplant 27: e935607.
20. (2019) Chinese Society of Organ Transplantation. Standard operating procedures for nursing care in heart transplantation. Electron J Pract Organ Transplant 7(5): 337-339.
21. Zhu X, Feng J, Wang Y (2021) Nursing care of an elderly patient with

fulminant myocarditis complicated by acute myocardial infarction undergoing emergency heart transplantation. Chin J Pract Nurs 37(31):2439-2443.

22. Chen M (2019) Chinese guidelines for the diagnosis and treatment of complications after heart transplantation (2019 edition). Chin J Transplant (Electron Ed) 13(1): 21-23.