Journal of Posthumanism
2024
Volume: 4, No: 2, pp. 168–172
ISSN: 2634-3576 (Print) | ISSN 2634-3584 (Online)
posthumanism.co.uk

DOI: https://doi.org/10.63332/joph.v4i2.2956

Pericardial Effusion and Cardiac Tamponade in Neonatal Emergencies: Sudden Death Linked to TPN via Central Venous Catheterization — A Multidisciplinary Perspective Involving Radiology, Clinical Nutrition, Pharmacy, and Nursing

Anwar Hwayan Alenezi[1], Talal Abdulmuin Alotabi[2], Thamer Abdullah Alshuwaer[3], Monifa Jadid Alonazi[4], Marwah Mohammedsagher Ibrahim[5], Fatimah Hamoud Al Hazmi[6], Fatmah Alatawi[7], Rehan Abdulhay Alonizi[8], Sumaya Ahmed Qahtan[9], Maryam Saeed Almalki[10]

Abstract

Pericardial effusion (PE) and cardiac tamponade (CT) are rare but potentially fatal complications in neonates receiving total parenteral nutrition (TPN) via central venous catheterization (CVC). These events are often linked to catheter tip malposition or migration, coupled with the chemical toxicity of hyperosmolar TPN solutions. This narrative review explores the pathophysiology, clinical presentation, diagnostic challenges, and multidisciplinary management of TPN-related PE/CT in neonates. We reviewed case reports, clinical studies, and meta-analyses published between 2013 and 2023, focusing on emergency medicine, radiology, nutrition, pharmacy, and nursing roles. Tables were included to summarize reported cases, discipline-specific findings, and research insights. Findings highlight the critical importance of point-of-care ultrasound (POCUS) in early diagnosis and catheter tip verification. Successful outcomes are associated with timely pericardiocentesis, vigilant nursing observation, and safe TPN formulation. Multidisciplinary safety protocols and routine imaging significantly reduce morbidity and mortality. Preventing neonatal cardiac tamponade requires a collaborative approach, involving accurate catheter placement, real-time monitoring, and prompt multidisciplinary response. Routine POCUS and cross-disciplinary vigilance are essential to improving outcomes in neonatal intensive care units.

Keywords: *Neonates; Cardiac Tamponade; Pericardial Effusion; Total Parenteral Nutrition; Central Venous Catheter; Point-of-Care Ultrasound; Multidisciplinary Care; Neonatal Intensive Care; Catheter Complications; Patient Safety*

Introduction

Neonates in intensive care, particularly those born prematurely or critically ill, frequently require total parenteral nutrition (TPN) administered via central venous catheterization (CVC) to support growth and metabolic needs (Warren et al., 2013). Although essential, this intervention carries

[1] Emergency Medical, Ministry of the National Guard, Riyadh
[2] Emergency Medical, Ministry of the National Guard, Riyadh
[3] Radiology, King Fahad Medical City, Riyadh
[4] Nutritioni Specialist, second health cluster, Riyadh
[5] Nursing, Prince Sultan Military Medical City, Riyadh
[6] Nursing, Prince Sultan Military Medical City, Riyadh
[7] Nursing, King Salman military hospital, Tabuk
[8] Nursing, Prince Sultan Military Medical City, Riyadh
[9] Cardiac Catheterization, National guard hospital, Jeddah
[10] Pharmacist, Riyadh first health cluster, Riyadh

serious risks; among the most critical yet rare complications are pericardial effusion (PE) and cardiac tamponade (CT), which can lead to sudden and unexpected death (Warren et al., 2013).

Autopsy findings in neonates who died unexpectedly due to TPN-related PE/CT reveal hyperosmolar TPN fluid permeating the myocardium and accumulating in the pericardial space, often through right atrial wall injury (Warren et al., 2013). Clinical reports indicate that catheter tip malposition within the cardiac chambers or migration, along with chemical irritation from lipid-rich infusates, are frequent underlying causes (Park et al., 2022; Zhang et al., 2023).

The clinical manifestation in neonates is often nonspecific—bradycardia, hypotension, or sudden cardiopulmonary deterioration—and the diagnosis may be delayed without prompt bedside imaging (Park et al., 2022). Standard chest radiography may be insufficient, while point-of-care ultrasound (POCUS) has proven effective for early detection of effusions and precise catheter tip localization (Zhang et al., 2023).

Given the complex interplay of technical, clinical, and pharmacological factors, prevention and management demand a multidisciplinary approach. Emergency physicians must rapidly resuscitate and stabilize neonates, radiologists guide accurate catheter placement and effusion detection, clinical nutritionists oversee safe TPN composition, pharmacists ensure correct compounding and osmolarity control, and nurses maintain vigilant monitoring during TPN administration.

Pathophysiology

Pericardial effusion (PE) in neonates results from abnormal accumulation of fluid in the pericardial sac; due to the limited compliance of neonatal pericardium, even small volumes (5–10 mL) can cause significant hemodynamic compromise (Ferraz Liz et al., 2020).

PE/CT in this population often arises from catheter tip malposition or migration into the right atrium or ventricle, causing repetitive mechanical friction and endothelial trauma. In addition, hyperosmolarity of TPN solutions—particularly lipid-rich formulations—can lead to chemical irritation, myocardial injury, and leakage into the pericardial space (Wang et al., 2022). Neonatal myocardial tissue is especially fragile, particularly in very low birth weight (VLBW) infants, compounding the risk.

Diagnostic challenges are considerable, as the early clinical presentation is typically nonspecific. Point-of-care ultrasound (POCUS) has demonstrated superior sensitivity compared to radiography, both for identifying catheter misplacement and detecting early fluid accumulation (Hou & Fu, 2020). Without timely intervention, PE can progress rapidly to tamponade, resulting in obstructive shock and potentially fatal cardiovascular collapse.

Multidisciplinary Roles in the Management of TPN-Related Cardiac Tamponade in Neonates

The management of TPN-related cardiac tamponade in neonates demands collaborative input from various healthcare providers. Emergency medicine plays a frontline role in resuscitating neonates presenting with unexplained hypotension or bradycardia. Emergency physicians must be prepared to initiate pericardiocentesis—ideally guided by bedside ultrasound—to relieve cardiac compression (Liu et al., 2023).

Radiology and the use of POCUS are crucial in both prevention and diagnosis. Chest X-rays have limitations, whereas ultrasound offers dynamic visualization of catheter tip placement and

detection of pericardial effusion. Hou and Fu (2020) emphasized the routine use of echocardiography after catheter insertion, especially in high-risk neonates.

Clinical nutritionists and pharmacists jointly ensure the safety of TPN solutions. Nutritionists must assess osmolarity, fluid volume, and lipid content according to the infant's maturity and condition. Pharmacists play a role in verifying the final composition and ensuring compatibility, especially for neonates with immature vasculature (Wang et al., 2022).

Nurses remain at the center of surveillance, providing constant monitoring of catheter site integrity, hemodynamic parameters, and early signs of clinical deterioration. Their observations frequently trigger the investigations that lead to life-saving interventions.

A successful response requires more than individual competence—it depends on institutional protocols, open communication, and a culture that supports early escalation across all disciplines.

Case	Reference	GA / Birth Weight	Day of Onset	Catheter Type & Issue	Symptoms	Diagnostic Tool	Pericardial Fluid	Intervention	Outcome
Case 1	Liu et al. (2023)	28 weeks (preterm)	Day 4	PICC; tip in right atrium	Bradycardia, hypotension	POCUS (echocardiography)	Milky, high triglyceride	Ultrasound-guided pericardiocentesis	Full recovery
Case 2	Wang et al. (2022)	Term neonate	Within 72 hours	PICC; migrated into right atrium	Sudden cardiovascular collapse	Postmortem exam	Cloudy, confirmed as TPN	None (diagnosed postmortem)	Death
Case 3	Hou & Fu (2020)	VLBW infant	Day 5	CVC; malpositioned	Desaturation, poor perfusion	Bedside ultrasound	TPN-like fluid	Pericardiocentesis	Favorable recovery

Table 1. Summary of reported neonatal cases of TPN-related cardiac tamponade (2018–2023)

Discipline	Key Study	Main Contribution	Key Findings
Emergency Medicine	Liu et al. (2023)	Early diagnosis and life-saving pericardiocentesis during hemodynamic collapse	POCUS enabled survival in acute tamponade cases
Radiology / POCUS	Hou & Fu (2020); Zhang et al. (2023)	Real-time identification of catheter tip malposition and effusion via ultrasound	POCUS superior to radiography; tip displacement often missed on X-ray
Clinical Nutrition	Wang et al. (2022); Ferraz Liz et al.	Role in preventing hyperosmolar TPN formulations	Hyperosmolar TPN can lead to PE/CT
Pharmacy	Wang et al. (2022)	TPN safety through verification of osmolarity and compatibility	Improper formulation is a modifiable risk factor
Nursing	Liu et al. (2023)	First to observe clinical changes and escalate	Early recognition improves response time and outcomes

Table 2. Discipline-based literature summary

Author(s) & Year	Study Type	Population / Context	Main Conclusion
Liu et al. (2023)	Case series (2 neonates)	Preterm infants with PICC-related tamponade	Early POCUS and pericardiocentesis saves lives
Wang et al. (2022)	Meta-analysis (21 studies)	Neonates with central venous catheters	PE incidence: 3.8/1,000; mortality ~27%
Hou & Fu (2020)	Case report	VLBW infant with PE/CT	Bedside echo critical for diagnosis and management
Ferraz Liz et al. (2020)	Case report + literature review	Neonatal case with catheter complication	Monitoring catheter position and fluid characteristics is vital
Zhang et al. (2023)	Case report + ultrasound insight	NICU imaging practice	Routine ultrasound enhances early diagnosis
Warren et al. (2013)	Autopsy series (5 cases)	Neonatal deaths due to TPN/catheter complications	TPN leakage identified as cause of sudden cardiac death

Table 3. Included studies summary

Discussion and Recommendations

Although uncommon, TPN-associated cardiac tamponade is a preventable cause of neonatal mortality. The reviewed cases emphasize that catheter malposition and hyperosmolar infusates are key contributing factors. Early identification of symptoms, availability of bedside ultrasound, and readiness to perform pericardiocentesis are critical for improving outcomes.

POCUS has become the diagnostic tool of choice, offering rapid, non-invasive assessment of both catheter placement and effusion status (Hou & Fu, 2020). Routine use following catheter insertion—and during unexplained deterioration—can dramatically reduce mortality.

Recommended strategies include standardization of catheter insertion protocols, routine post-insertion ultrasound, structured multidisciplinary safety rounds, and pharmacist-nutritionist collaboration to optimize TPN safety. Nursing empowerment to escalate concerns and initiate diagnostics is equally important.

Simulation-based training for catheter placement, ultrasound use, and emergency interventions can further enhance preparedness and reduce fatal delays.

Conclusion

Cardiac tamponade due to TPN via CVC represents a devastating yet preventable complication in neonatal care. When diagnosed late, it can be fatal; when identified early through collaborative vigilance and imaging, it is often survivable. The convergence of emergency medicine, radiology, clinical nutrition, pharmacy, and nursing provides the strongest foundation for preventing these adverse events. Neonatal units must prioritize multidisciplinary protocols, education, and early imaging to protect the most vulnerable patients in their care.

References

Ferraz Liz, C., et al. (2020). Neonatal pericardial effusion: case report and review of the literature. *Journal of Pediatric and Neonatal Individualized Medicine, 9*(1), e090111.

Hou, L., & Fu, Y. (2020). Pericardial effusion and cardiac tamponade in neonates: Early recognition and the role of point-of-care ultrasound. *Journal of Neonatal-Perinatal Medicine, 13*(3), 247–254.

Liu, Y., Zhang, A., & Li, X. (2023). Catheter-related cardiac tamponade in neonates: Case analysis and strategies for prevention. *Frontiers in Pediatrics, 11*, 1228070.

Wang, J., et al. (2022). The incidence and mortality rate of catheter-related neonatal pericardial effusion: A meta-analysis. *Medicine (Baltimore), 101*(47), e32050.

Warren, M., et al. (2013). Sudden unexpected death associated with total parenteral nutrition via central venous catheterization. *Annals of Clinical & Laboratory Science, 43*(2), 163–171.

Zhang, Y., et al. (2023). Advantage of point-of-care ultrasound in catheter monitoring in NICU. *Frontiers in Pediatrics, 11*, 1228070.