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# Nursing Protocol for Managing Rodenticide-Induced Acute Liver Failure with Low Volume Plasma Exchange

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**Abstract:** ***Rodenticide poisoning, particularly from yellow phosphorus ingestion, remains a life-threatening condition in India due to the absence of specific antidotes and limited access to liver transplantation. Low Volume Plasma Exchange (LVPE) has emerged as a practical and effective therapeutic intervention for managing such cases, particularly in resource-constrained settings. This article presents a comprehensive clinical nursing protocol for managing rodenticide toxicity using LVPE, including patient preparation, monitoring, and post-procedure care. Emphasis is placed on the nurse's role in early identification of complications, coordination with interdisciplinary teams, and patient education. By standardizing the nursing approach to LVPE, this protocol aims to improve patient outcomes, enhance safety, and support nurses in delivering evidence-based care for toxicological emergencies.***

**Keywords:** low volume plasma exchange, nursing protocol, yellow phosphorus poisoning, rodenticide toxicity, Acute liver failure

## 1. Introduction

Rodenticide poisoning remains a significant public health challenge in India, Aluminum phosphide (AlP) and yellow phosphorus (YP) being among the most toxic agents. These compounds are associated with high mortality due to rapid multi-organ failure and the absence of specific antidotes. Therapeutic plasma exchange (PLEX) has emerged as a potential intervention to mitigate toxicity by removing toxins or inflammatory mediators. Particularly low-volume PLEX, has been established as a promising and effective therapy for rodenticide-induced ALF, improving transplant-free survival in children and adults. The research studies advocate for early initiation of PLEX combined with comprehensive supportive care to optimize the clinical outcomes. These findings are particularly relevant in India, where access to liver transplantation is limited, hence, PLEX has become a critical component of management for rodenticide hepatotoxicity. This article aims to present a structured nursing protocol for managing rodenticide-induced acute liver failure through low-volume plasma exchange, emphasizing safe practice, interdisciplinary collaboration, and improved patient outcomes in resource-limited settings. The development of this clinical protocol is significant because it addresses standardized nursing management for rodenticide poisoning in a tertiary care hospital in Tamilnadu, India. It provides an evidence-based framework that can enhance nursing competence, reduce complications, and support healthcare systems in regions with limited access to advanced liver support interventions

**Epidemiology and Clinical Burden of Rodenticide Poisoning in India**

Rodenticides like AlP and YP are widely used in agricultural and household settings across India, leading to frequent cases of accidental or intentional poisoning. Aluminum phosphide reacts with gastric acid to release phosphine gas, which inhibits mitochondrial respiration and causes cellular hypoxia(1) (2). Mortality rates range from 35% to 85%, with death often occurring within 24 hours due to refractory shock or cardiac arrest. Yellow phosphorus, a hepatotoxic rodenticide, induces acute liver failure, often necessitating liver transplantation in severe cases The lack of antidotes underscores the need for adjunct therapies like PLEX to improve survival(3)

**Yellow Phosphorus Poisoning: PLEX as a Bridge to Transplantation**

After 1–3 sessions of PLEX, 72.7% of patients show significant reductions in liver enzymes (AST/ALT) and bilirubin levels. PLEX reduces inflammatory mediators like IL-6 and TNF-α, delaying hepatic necrosis and improving survival(4)

**Mechanisms of Plasma Exchange in Toxin Clearance:** PLEX removes high-molecular-weight toxins, inflammatory cytokines, and phosphine-hemoglobin complexes from circulation(5). In AlP poisoning, phosphine gas binds to hemoglobin, disrupting oxygen transport and exacerbating metabolic acidosis(6). By replacing toxic plasma with fresh frozen plasma or albumin, PLEX may restore acid-base balance and reduce oxidative stress. Similarly, in YP poisoning, PLEX eliminates lipid-soluble toxins and mitigates hepatic inflammation(7). Clinical studies suggest that early intervention with PLEX—ideally within 6–12 hours of exposure—correlates with better outcomes by preventing irreversible organ damage (3)

**Toxin and Inflammatory Mediator Removal:** PLEX facilitates the removal of circulating toxins, inflammatory cytokines (such as IL-6 and TNF-α), and harmful metabolic products that contribute to ongoing liver injury and systemic inflammation. This reduces the severity of the inflammatory

cascade and multi-organ dysfunction, which are key drivers of mortality in ALF(2).

**Improvement in Coagulation and Biochemical Parameters:** Plasma exchange replenishes coagulation factors by replacing patient plasma with fresh frozen plasma, leading to improvements in INR and other coagulation markers. It also lowers bilirubin, transaminases (AST, ALT), and ammonia levels, reflecting partial biochemical recovery of liver function(2,4).PLEX's benefits also involve modulation of systemic inflammation.

**Survival Benefit Compared to Standard Medical Therapy:** Studies show that patients treated with PLEX have significantly lower 30-day mortality compared to those receiving standard medical treatment alone. For example, one propensity-matched analysis found 21% mortality with PLEX versus higher rates with standard care (1). Randomized controlled trials in ALF patients demonstrated improved transplant-free survival with plasma exchange, particularly in those who did not undergo liver transplantation (2)(3).

**Low-Volume Plasma Exchange as a Feasible Alternative:** Low-volume PLEX (exchanging smaller plasma volumes per session) is especially valuable in low-resource settings or for patients with hemodynamically unstable conditions. It has been successfully used in various conditions, including liver failure, with comparable efficacy to conventional high-volume PLEX. Low-volume PLEX is better tolerated, less costly, and can be repeated over multiple sessions to achieve cumulative benefit (6).

**Earlier Recovery and Reduced Complications**: Patients receiving low-volume PLEX often show earlier clinical improvement and fewer adverse effects compared to those undergoing conventional plasma exchange. This approach has been used effectively in chronic and acute conditions, supporting its safety and feasibility(8)

**Clinical Profile Insights**

The characteristic clinical progression of YP poisoning is into three stages:

- **Stage 1 (0–24 hours):** Often asymptomatic or mild gastrointestinal symptoms.
- **Stage 2 (24–72 hours):** Apparent resolution of initial symptoms, leading to a deceptive improvement phase.
- **Stage 3 (>72 hours):** Onset of fulminant hepatic failure, acute kidney injury (AKI), coagulopathy, encephalopathy, and high mortality risk.

This staging helps nurses anticipate the delayed yet severe systemic toxicity of YP and highlights the importance of vigilant monitoring even when early symptoms appear mild or absent(9)

**Pathophysiological Rationale for Early Intervention**

YP ingestion causes direct hepatocyte injury through lipid peroxidation and mitochondrial dysfunction, releasing damage-associated molecular patterns (DAMPs) and pro-inflammatory cytokines like IL-6 and TNF-α within 24–48 hours These mediators propagate a systemic inflammatory response syndrome (SIRS), exacerbating hepatic encephalopathy (HE), coagulopathy, and acute kidney injury (AKI).

**PLEX intervenes by**:

1) **Removing Lipid-Soluble Toxins**: YP metabolites, including phosphine gas and reactive oxygen species (ROS), bind to plasma proteins and are efficiently cleared via PLEX (1)(2).
2) **Reducing Cytokine Burden**: Elevated IL-6 (>500 pg/mL) and TNF-α (>200 pg/mL) correlate with ALF severity and are reduced by 40–60% after a single PLEX session (4)(2).
3) **Restoring Coagulation Factors**: Fresh frozen plasma (FFP) replacement during PLEX replenishes clotting factors (e.g., fibrinogen, factor V), lowering INR from >3.5 to <1.8 within 48 hours (1)(2).

Delayed PLEX initiation allows toxins to accumulate beyond a critical threshold, rendering hepatic recovery unlikely.

**Management of Yellow phosphorus-based rodenticide poisoning in emergency department:**

Yellow phosphorus is absorbed through the gastrointestinal tract and respiratory mucosa. It affects ribosomal function, which leads to defective protein synthesis. It also impairs glucose homeostasis and lipoprotein and triglyceride metabolism. This leads to fatty degeneration of the liver, kidney, and brain.

**Clinical stages of intoxication:**

Stage 1: Within 24 hours, patients may be asymptomatic or have mild gastric discomfort.
Stage 2: Within 24-72 hours, symptoms may resolve.
Stage 3: After 72 hours, patients may develop acute liver failure (ALF), coagulopathy, hypotension, cardiac arrythmias, and acute kidney injury.

**Initial Assessment and Stabilization**:

- Ensure the patient's airway is clear, provide adequate ventilation, and maintain circulatory support.
- Continuously monitor blood pressure, heart rate, respiratory rate, and oxygen saturation.
- Gastric Lavage may be considered if the patient presents within 1 hour of ingestion. Activated Charcoal is administered to limit gastrointestinal absorption, preferably within 1–2 hours post-ingestion.
- NAC may be administered as an antidote if the patient presents < 12 hrs. Dose:150mg/kg in 200ml of 5% dextrose over 15 min, then 50mg/kg in 500ml of 5% dextrose over 4 hours, then 100mg/kg in 1 litre of 5% dextrose over 16 hours
- Administer Vitamin K1 10mg IV stat

**Monitoring and Supportive Care**:

- Assess hepatic enzymes, bilirubin levels, and coagulation profiles to detect early signs of hepatotoxicity.
- Monitor serum creatinine and urine output to assess renal function
- Regularly check the electrolytes and correct imbalances.
- Administer intravenous fluids to maintain hydration and support renal function.

**Plasma Exchange (PLEX) Procedure**

Plasma Exchange may be considered in cases of acute liver failure to remove toxins and inflammatory mediators. However, patients may be evaluated for transplantation if unresponsive to medical management. The patient will be admitted for close monitoring in HDU / ICU.

**Role of the nurse in PLEX**

Nurses play a critical role in preparation, monitoring, managing potential complications, and monitoring for any adverse reactions. The Nurse coordinates the care and acts as the patient advocate.

**Patient assessment and preparation**

a) The nurse must inform the patient about the process of PLEX, and counsel the patient
b) The nurse obtains informed consent to perform the treatment and collects a complete patient history
c) A hepatologist will decide the preferred site for port insertion, either a peripheral line or a central line. For the central line, the femoral port insertion will be done. Local preparation for the port site is done.
d) The nurse is responsible for taking and sending pre-PLEX blood sample to the lab.
   - Blood samples are taken for CBC (baseline Hb> 7 gm% targeted), Ferritin, Creatinine, LFT, serum sodium, Potassium, Calcium and Phosphorus
   - Serum lipase, triglycerides, LDH
   - Lactate, TEG, PT, aPTT, Fibrinogen and D-dimer
   - VWF (Antigen) assay, ADAMTS13 antigen

As soon as the PLEX decision is made, the Patient will be started on Tab. Prednisolone 10mg bd, Tab. Zinc acetate 50mg bd, Tab. NAC 600mg bd and Tab. Shelcal 1gm.The replacement fluid (FFB) will be given according to the weight of the patient.

**Nursing Considerations During PLEX Procedure:**

**Continuous Monitoring of Vital Signs and Patient Condition: B**lood pressure, heart rate, respiratory rate, oxygen saturation, and temperature will be monitored at regular intervals to detect early signs of hypotension, hypoxia, or febrile reactions. Neurological status and level of consciousness will be monitored to identify any acute changes.

**Observation for Adverse Reactions: S**ymptoms such as flushing, itching, chills, nausea, vomiting, headache, back pain, or signs of allergic reactions will be observed and intervened promptly. Plasma exchange can cause complications such as hypotension, allergic reactions, citrate toxicity (leading to hypocalcemia), bleeding, and fluid imbalances. Continuous monitoring of blood pressure, heart rate, respiratory rate, and oxygen saturation allows nurses to detect these changes promptly and intervene before they become severe

**Machine and Circuit Monitoring: T**he plasmapheresis machine parameters, including blood flow rate, transmembrane pressure (TMP), plasma volume removed, anticoagulant infusion, and replacement fluid administration, will be continuously observed. Machine alarms will be set and attended immediately for air detection or blood leaks as per protocol to prevent complications like air embolism or circuit clotting. Should ensure proper functioning of the extracorporeal circuit and maintain patency of vascular access

**Vascular Access Care:** The nurse maintains aseptic technique when handling central venous catheter or peripheral line to prevent infection. Monitors access sites for bleeding, hematoma, or signs of infection during and after the procedure. Secures lines properly to prevent dislodgement or poor blood flows

**Documentation:** Accurately record vital signs, machine settings, volume of plasma exchanged , replacement fluids used, anticoagulant doses, and any adverse events or interventions. Update patient care records continuously to facilitate communication within the multidisciplinary team.

**Patient Comfort and Support**: Provide reassurance and psychological support throughout the procedure to reduce anxiety. Manage patient positioning to ensure comfort and prevent complications like nerve compression or pressure sores. Encourage communication so patients can report any discomfort or symptoms immediately.

**Preparation for Emergency Interventions:** Have emergency medications and equipment readily available to manage allergic reactions, hypotension, or other acute complications. Be prepared to stop the procedure and initiate resuscitation if severe adverse events occur. These nursing considerations are essential to ensure the safety, efficacy, and patient-centered care during PLEX, minimizing risks and optimizing treatment outcomes

**Post procedure care**

1) Monitor the patient for delayed complication like bleeding or infection at the port site.
2) Assessing patient comfort and providing necessary intervention for side effects like nausea, dizziness or muscle cramps,
3) Inj. Calcium gluconate 10% 20ml with 250ml NS is given for 1 hr
4) Educating the patient about post procedure care insertion, including hydration and monitoring for any potential symptoms.
5) After 8hrs of the procedure, post blood PLEX sample to be send to the laboratory

Empirical antibiotic prophylaxis will be initiated 24 hours before PLEX procedure to avoid infections. Low dose of steroid (prednisolone 10 mg once a day) before 24 hours of procedure to till follow up, based on the clinical condition and lab parameters (LFT and total counts) drug dose tapered to 5 mg and stopped. Zinc supplements were administered (T. Zinc 50 mg twice a day) one day prior the procedure till the follow up to decrease the intestinal permeability. N-Acetylcysteine (NAC) for acetaminophen toxicity.

**Patient Education:** Inform the patient about possible fatigue or tiredness lasting 1-2 days and advise rest and avoidance of strenuous activities. Encourage fluid intake to prevent dehydration and support recovery

**Ongoing Monitoring:** Continue to monitor laboratory parameters such as calcium, potassium, magnesium, and coagulation profile to detect and manage electrolyte imbalances or coagulopathies. Watch for delayed complications like allergic reactions or infections and intervene promptly

**Coordination and Communication**(10)

- Multidisciplinary Collaboration: Facilitate communication between the patient, nursing staff, physicians (hematologists, nephrologists), and apheresis specialists to ensure coordinated care
- Patient Support: Provide emotional support and address patient and family concerns throughout the treatment course
- Quality Assurance:Adhere to institutional protocols and guidelines for PLEX to ensure safety and quality of care

**Nurses role in Vascular access management:**

Nurses manage vascular access and prevent infections through strict adherence to aseptic techniques, careful assessment, maintenance, and patient education, ensuring safe and effective use of vascular devices during procedures like plasma exchange.

1) **Proper Selection and Insertion of Vascular Access**
   Assess patient-specific factors (therapy type/duration, vein condition) to select the most appropriate vascular access device (peripheral IV, central venous catheter) Ensure insertion is performed under maximum sterile barrier precautions (sterile gown, gloves, mask, cap, full-body drape) to minimize infection risk
2) **Strict Hand Hygiene and Aseptic Technique**
   Perform hand hygiene rigorously before and after handling vascular access devices; this is the single most important measure to prevent bloodstream infections. Use sterile gloves and maintain aseptic technique during dressing changes, line access, and blood sampling
3) **Regular Assessment and Monitoring**
   Inspect vascular access sites frequently for signs of infection: redness, swelling, warmth, tenderness, purulent discharge, or bleeding. Monitor for complications such as infiltration, thrombosis, or hematoma.
4) **Dressing and Site Care**
   Change dressings according to institutional protocols or if soiled or loose, using aseptic technique. Disinfect needleless connectors and catheter hubs before access
5) **Maintenance and Patency**
   Flush catheters as per protocol to maintain patency and prevent occlusion. Avoid unnecessary manipulation or access of the device. Secure lines properly to prevent dislodgement or trauma

**Challenges and Recommendations for PLEX Implementation in India**

1) **Timely Access**: Delays in transferring patients to centers with PLEX capabilities remain a barrier. Rural outreach programs and mobile PLEX units could mitigate this(4,11)
2) **Cost and Resources**: PLEX requires specialized equipment and donor plasma, which are scarce in low-resource settings. Government subsidies and public-private partnerships are critical(3)
3) **Standardized Protocols**: Evidence-based guidelines for PLEX timing, volume, and session frequency are needed to optimize outcomes (2)

## 2. Summary

Low-volume plasma exchange sessions improve survival outcomes in rodenticide-induced acute liver failure by removing toxins and inflammatory mediators, correcting coagulopathy, and supporting liver recovery. Compared to standard medical therapy, PLEX reduces mortality and can serve as a critical bridge to transplantation or recovery, especially in resource-limited settings. Low-volume PLEX offers a practical, safer, and cost-effective alternative to conventional plasma exchange, facilitating wider accessibility and earlier intervention. This structured approach ensures safe, effective, and patient-centered nursing care throughout the therapeutic plasma exchange process, minimizing complications and improving patient outcomes. During the PLEX procedure, nursing considerations focus on continuous patient and machine monitoring, early detection of complications, and ensuring patient safety and comfort.

Nursing care plays a pivotal role in the safe and effective delivery of plasma exchange (PLEX) for patients with rodenticide poisoning. Before the procedure, nurses are responsible for baseline assessments, including vital signs, coagulation profile, complete blood count, and electrolyte levels. Establishing central venous access, ensuring informed consent, and preparing necessary equipment are essential pre-procedural tasks. During the PLEX procedure, nurses continuously monitor hemodynamic parameters, detect early signs of complications such as hypotension, allergic reactions, hypocalcemia, or bleeding, and maintain strict aseptic technique to reduce infection risk. Administration of replacement fluids, calcium supplementation, and anticoagulants must be carefully managed as per protocol. Post-procedural care involves monitoring the patient for delayed bleeding, line-related infections, and electrolyte imbalances. Documentation of all observations, interventions, and responses is vital for continuity of care. Nurses also play a key role in patient and family education—explaining the nature of rodenticide toxicity, importance of continued vitamin K therapy, and signs of recurrence or bleeding. Overall, nursing vigilance, technical competence, and effective interdisciplinary communication are crucial to ensuring patient safety and optimizing outcomes in PLEX therapy for toxicological emergencies.

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