



Nursing roles and responsibilities in cryopreservation within pediatric care

¹Amaravathi D, ²Jaikumar J and ³Rajalakshmi S

¹Ph.D. Research Scholar, BIHER, Selaiyur, Bharath University, Chennai, Tamil Nadu, India

²Professor, Sri Lakshmi Narayana institute of medical science, Bharath University, Puducherry, India

³Principal, Sri Lakshmi Narayana College of Nursing, Bharath University, Puducherry, India

Corresponding Author: Amaravathi D

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Abstract

Cryopreservation of biological tissues, cells, or organs at ultra-low temperatures is increasingly vital in paediatric care for children at risk of fertility or immune impairment due to medical treatments. Advances in verification, cryoprotectants, and bio banking have significantly enhanced the viability and safety of specimens, including hematopoietic stem cells, ovarian and testicular tissue, mature gametes, and cord blood. Nurses play a central role in this process, providing patient and family education, facilitating informed consent and assent, coordinating pre, intra, and post-procedure care, ensuring specimen handling and documentation, and offering long-term follow-up and psychosocial support. Ethical and legal considerations, including autonomy, confidentiality, tissue ownership, and regulatory compliance, are integral to the practice. Case scenarios demonstrate how nursing interventions support families through fertility preservation. Overall, nurses ensure holistic, family-centered care that safeguards patient rights, enhances outcomes, and preserves future health and reproductive options.

Keywords: Cryopreservation, pediatrics, nursing roles, fertility preservation, stem cells, ovarian tissue, testicular tissue, ethical considerations, informed consent, psychosocial support, bio banking

Introduction

Cryopreservation the ultra-low temperature preservation of tissues, cells, or organs has become essential in pediatric care, offering children with cancer, congenital disorders, or complex surgeries the chance to safeguard future fertility, immune function, and long-term health. Advances in verification, cryoprotectants, and bio banking have enhanced the safety and viability of specimens such as ovarian and testicular tissue and hematopoietic stem cells. As survival rates improve, focus on long-term quality of life has made fertility preservation and tissue storage increasingly important. Pediatric cryopreservation also presents ethical, developmental, and consent-related challenges, necessitating family-centered decision-making, while supporting emerging regenerative and personalized therapies.

Background

Survival rates among pediatric cancer patients have improved significantly, shifting clinical focus toward long-term quality of life, including future fertility. Many treatments carry a high risk of gonadal damage, highlighting the need for fertility preservation. Advancements in stem cell technologies have increased the demand for the collection and banking of biological tissue. Nurses serve as a critical link between families and multidisciplinary teams,

ensuring that procedures are safe, ethically sound, and clearly understood. Their responsibilities extend beyond technical tasks to holistic, psychosocial care, addressing emotional sensitivities surrounding childhood illness and reproductive potential.

Cryopreservation in pediatric care

Cryopreservation involves cooling biological materials such as cells, tissues, or organs to very low temperatures, typically using liquid nitrogen, to halt metabolic activity and prevent deterioration. Preserved materials remain viable for extended periods and can be safely thawed for future medical, reproductive, or research use.

In pediatric care, cryopreservation specifically refers to the preservation of children's cells and tissues, including hematopoietic stem cells, ovarian or testicular tissue, mature gametes (in adolescents), and cord blood to maintain long-term viability. It supports children undergoing gonadotoxic therapies and emerging regenerative treatments. Beyond the technical procedure, pediatric cryopreservation involves ethical considerations, consent, family counseling, and long-term planning, making it a critical component of comprehensive pediatric care.

Overview of scientific basis

Cryopreservation works by cooling cells or tissues to ultra-

low temperatures (typically below -150°C), effectively halting biological activity and preventing degradation. Cryoprotective agents (CPAs) prevent ice crystallization, which can damage cell membranes.

In pediatrics, cryopreservation is commonly performed for:

- Hematopoietic stem cells
- Ovarian or testicular tissue
- Mature gametes (adolescents)
- Cord blood

Nurses must understand cryobiology principles to prepare patients, explain procedures to families, and maintain specimen integrity during collection and transport.

Clinical context and presentation

Cryopreservation itself does not produce clinical symptoms. However, it is indicated in contexts such as:

- Cancer diagnoses
- Blood disorders
- Autoimmune diseases requiring aggressive immunosuppression
- Congenital or genetic conditions affecting fertility

Nurses assess the child's physical, psychological, and developmental readiness and identify potential risks affecting tissue collection, sedation, or anesthesia.

Pre-procedure nursing responsibilities

Diagnosis

- Baseline blood tests
- Hormonal profiling in adolescents
- Infectious disease screening (HIV, Hep B, Hep C)
- Imaging (ovarian ultrasound, testicular exam)

Documentation and consent

- Valid informed consent from parents/guardians
- Assent from older children/adolescents
- Documentation of storage duration, future use rights, and tissue ownership

Preparation for collection

- Maintaining NPO status if anesthesia is required
- Ensuring IV access
- Pain assessment
- Psychological preparation with child-life specialists

Nursing responsibilities during procedure

- Support the child through sedation or anesthesia
- Maintain sterile technique during tissue or cell collection
- Monitor vital signs and ensure comfort
- Accurate labeling and immediate handover of specimens
- Complete chain-of-custody documentation

Ethical and legal considerations

Nurses play a central role in addressing ethical and legal issues surrounding pediatric cryopreservation:

- **Informed consent and assent:** Ensuring parents/guardians and age-appropriate children

understand risks, benefits, and the experimental nature of some procedures

- **Autonomy and assent:** Advocating for the child's participation in decision-making, respecting developing autonomy
- **Confidentiality:** Protecting personal and genetic information related to stored tissues
- **Ownership and disposition of tissue:** Clarifying future use, research participation, or disposal rights
- **Regulatory compliance:** Adhering to national and institutional guidelines for pediatric tissue storage and biobanking

Nursing roles and responsibilities

1. **Patient and Family Education:** Explain purpose, benefits, limitations, and risks in age-appropriate terms; discuss timing and storage options.
2. **Emotional and Psychosocial Support:** Provide counseling, reassurance, and collaborate with child-life specialists or social workers.
3. **Coordination of Care:** Liaise with oncology, surgical, laboratory, and biobank teams; ensure timely collection before therapy.
4. **Informed Consent and Assent Support:** Assist in clarifying information, advocate for child's preferences.
5. **Pre-Procedure Preparation:** Ensure physical and emotional readiness, verify fasting status, and provide psychological comfort.
6. **Intra-Procedure Assistance:** Support clinicians, monitor vital signs, maintain sterile technique, and provide comfort.
7. **Post-Procedure Care:** Monitor for complications, provide pain management guidance, and educate on wound care.
8. **Handling and Transport of Specimens:** Ensure accurate labeling, chain-of-custody compliance, and safe transfer to biobank.
9. **Documentation and Compliance:** Maintain detailed records and follow legal and institutional protocols.
10. **Long-Term Follow-Up:** Guide families on storage decisions, future use, and provide ongoing support as children mature.

Post-procedure nursing care

- **Physiological Monitoring:** Bleeding, infection, pain, hydration, anesthesia recovery, wound care
- **Psychosocial Support:** Emotional reassurance, addressing questions on fertility or storage, referrals to counseling
- **Communication and Follow-Up:** Lab updates, scheduling follow-up visits, documentation

Prevention, quality, and safety measures

- Adherence to infection control and hand hygiene
- Verification protocols for specimen labeling
- Compliance with national and institutional standards
- Education on safe fertility practices for adolescents
- Early referral for psychosocial distress

Potential complications

- **Procedure-related:** Bleeding, infection, anesthesia

risks, pain

- **Psychosocial:** Anxiety about fertility, emotional distress
- **System-related:** Specimen mislabeling or mishandling, ethical complexities

Case scenarios

- **Case 1:** A 9-year-old boy with leukemia at risk for azoospermia undergoes testicular tissue cryopreservation. Nursing responsibilities included education, consent facilitation, biopsy coordination, specimen transport, and long-term follow-up for fertility counseling.
- **Case 2:** A 12-year-old girl with Hodgkin lymphoma at risk for premature ovarian failure undergoes ovarian tissue cryopreservation. Nursing roles included preoperative preparation, intraoperative support, postoperative care, specimen transport, long-term communication, and psychological support throughout treatment.

Key points

- Cryopreservation is critical for children facing fertility-threatening treatments.
- Nurses are central to patient education, psychosocial support, informed consent, and family-centered care.
- Strict adherence to chain-of-custody, labeling, and documentation ensures specimen safety.
- Nursing care spans assessment, preparation, procedural support, recovery, and long-term follow-up.
- Ethical and legal considerations are essential in protecting pediatric patient rights and guiding family decision-making.

Conflict of Interest

Not available.

Financial Support

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