國泰綜合醫院
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Building a Low-Stimulation, High-Quality, and Sustainable Care Environment for Preterm and Newborn Infants

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ABSTRACT

Preterm infants, due to their gestational immaturity, exhibit underdeveloped physiological systems—particularly in neurological and sensory integration functions—and are highly vulnerable to environmental stressors such as excessive light exposure, ambient noise, and frequent medical interventions. These stimuli can adversely affect autonomic regulation, delay physiological development, and impair neurobehavioral outcomes.

Through the implementation of the Developmental Care model, we optimized phototherapy frequency, minimized environmental noise, and enhanced both caregiving practices and family involvement, the accuracy rate of nursing staff's knowledge regarding developmental care reached 89.4%, thereby maintaining high-quality neonatal care.

And the preterm infants demonstrated an average daily weight gain of 20.1 grams, the implementation of the Developmental Care model has demonstrably reduced the environmental and procedural stressors associated with particularly for newborns and preterm infants in Neonatal Intensive Care Unit(NICU).

This approach effectively promotes stable growth and development while ensuring the delivery of high-quality, individualized care services, aligning with the United Nations SDGs 3.

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INTRODUCTION

Preterm infants are highly sensitive to external environmental stimuli such as intense lighting, noise, and frequent medical interventions, which may adversely affect physiological development and neurological outcomes.

We implemented the principles of Developmental Care in NICU, focusing on optimizing staff competencies, improving the clinical environment, and enhancing family involvement in care. This approach aims to promote physiological stability and neurobehavioral development in preterm infants during their NICU stay, while also advancing care quality, and fostering innovation and sustainability in neonatal care delivery.

METHODS AND MATERIALS

The intervention was structured around three core strategies:

1. Environmental Aspect – Light Regulation
   1) Lights were turned off nightly from 22:00 to 07:00 to support circadian rhythm development in preterm infants. Incubator covers were replaced with opaque materials to maintain a stable sleep environment.
   2) A novel "light-shielding cap" was created using soft, insulating fabric and neonatal eye masks to ensure visual protection during procedures.
2. Environmental Aspect – Sound Control
   1) Large-screen decibel monitors provided real-time noise surveillance, with visual alerts prompting staff to maintain low noise levels.
   2) Incubator door latches were padded to reduce sound during opening and closing.
   3) Alarm volumes on medical devices (e.g., monitors, ventilators) were lowered, and staff were required to respond within five tones to minimize auditory stress.
   4) A custom neonatal earmuff ("Shield for You") was tailored to individual ear shapes for optimal noise insulation during procedures or high-noise exposure.
3. Care Ascept – Therapeutic Touch and Positioning
   1) Workshops and hands-on training enhanced nursing staff's developmental care knowledge and skills.
   2) Educational posters on preterm care were displayed in nursing stations and family areas to support consistent practice.
   3) Multimedia videos demonstrating "nesting positioning" and "comfort holding" techniques were produced for ongoing learning by staff and families.

RESULTS

1. Sleep and Light Management
   - Nighttime light-off compliance reached 98%, significantly reducing light-related stimulation.
2. Noise Control Improvements
   - Hourly noise exceedance events decreased from an average of 13.2 to 4.4, a 66.7% reduction.
   - Staff compliance with noise-reduction protocols increased from 32.5% to 87.1%.
   - Utilization rate of custom neonatal earmuffs reached 100%, effectively minimizing auditory exposure.
3. Enhancement of Therapeutic Care Skills
   - Correct understanding of developmental care among staff improved from 59.1% to 89.6%, achieving a 105.4% target rate.
   - Clinical accuracy in nesting and comfort-holding techniques rose from 63.1% to 91.6%.
4. Improvement in Clinical Developmental Indicators
   - Average daily weight gain in preterm infants increased from 15.9g to 20.8g, contributing to reduced hospitalization duration.
5. ESG Sustainability Outcomes
   - Nighttime light-off measures reduced NICU electricity consumption by approximately 15%, saving ~500 kWh per month and lowering annual carbon emissions by ~3,600 kg .

GRAPHS AND TABLES



R&D "light-shielding cap"



R&D "neonatal earmuff "



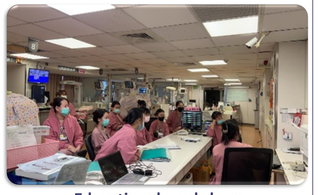
Large-screen decibel monitors



hands-on training



Guiding family members



Educational workshops

DISCUSSION

1. Innovative Sensory Protection Devices for Preterm Infants：
   These devices are currently under patent application.
2. Improved Compliance with Noise Reduction Protocols：
   Improved Compliance with Noise Reduction Protocols Among Nursing Staff, this aligns with previous recommendations include educating staff to raise awareness, and encouraging staff to limit conversation near infants (Brown, 2009).
3. Enhanced Growth Outcomes in Preterm Infants：
   Enhanced Growth Outcomes in Preterm Infants(20.8g), this outcome is consistent with international recommendations for optimal neonatal growth(15g to 35g per day) (WHO, 2022).
3. Correct understanding of developmental care：
   Correct understanding of developmental care among staff improved increased to 89.6%, exceeding the international benchmark of 86.3% reported in prior research (Lee & Cho, 2023).
3. Response to SDGs：
   By mitigating environmental stressors and optimizing care delivery, the intervention indirectly enhanced weight gain and reduced neonatal mortality, aligning with SDGs 3.1&3.2.

CONCLUSIONS

This study demonstrates a clinically effective and environmentally responsible model of developmental care, offering a replicable framework for NICUs globally and contributing to the advancement of neonatal health and sustainable healthcare practices.

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