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Practical Aspects of Pediatrics and Neonatology *for Nurses*

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Foreword
Vilhekar KY

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CHAPTER 19

Common Bedside Equipment

BILIRUBINOMETER

Bilirubinometer (Fig. 19.1) is a simple bedside equipment to measure total bilirubin by spectrophotometry and useful in the management of neonatal jaundice.

Equipment

Microcentrifuge to spin the blood, lancet, capillary tube, wax to seal one end of the capillary tube and bilirubin measuring part of the equipment.

Procedure

1. Collect blood in a heparinized capillary tube.
2. Dip one end of the capillary tube in the wax and keep it in the centrifuge.
3. For balance, keep another capillary tube in the opposite side and set the time.
4. After centrifuging, pull out the cell holder and keep it in the measurement part of the bilirubinometer and the result displays in seconds.

Advantages

1. The result is available within 5 minutes and measured at bedside.
2. Blood volume required is about 0.1 mL, i.e. 1 or 2 drops.
3. No reagent, calibration or recurrent expenses are required.



Fig. 19.1: Bilirubinometer

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PHOTOTHERAPY

Phototherapy is a safe and effective method of treatment of neonatal unconjugated hyperbilirubinemia. Exposure of the jaundiced infant to blue, white or green light is effective in reducing the serum bilirubin level. When bilirubin absorbs light, several types of photochemical reactions occur. They are:

1. Geometric photoisomerization of unconjugated bilirubin resulting in a more soluble form of bilirubin (80%).
2. Structural isomerization, converting bilirubin into lumirubin, which can be excreted into bile without conjugation.
3. Oxidation mechanism resulting in colorless byproduct and excreted by liver and kidney without conjugation.

Indications

- Increase in the bilirubin level due to physiological or pathological jaundice
- Prophylactic phototherapy is indicated in extremely low-birth weight babies.

Contraindications

- Conjugated jaundice.

Setup of Phototherapy Unit

Phototherapy generally consists of four day bright and cool white lamps, which have a spectral peak between 550 to 600 nm and four special blue light having a range of 420 to 480 nm covered by a plastic shield and placed about 45 cm away from the baby. Bilirubin absorbs light maximally in blue range (420–450 nm). The efficiency of phototherapy depends on energy output of the spectrum and on the surface area of the infant exposed to those lights. Blue light masks the clinical signs of cyanosis and color change in the infant and causes headache and nausea to the caregivers. Hence, a combination of both white and blue color lamps are preferred. A unit with four special blue and four daylight will give an effective irradiance of 11 $\mu w/cm^2/nm$, which is far above the required 4 to 6 $\mu w/cm^2/nm$. The plastic shield absorbs ultraviolet irradiation. A photoreaction occurs in the very outer layers

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of the skin. Once phototherapy has been initiated, serum levels of bilirubin must be monitored frequently, because visual assessment of icterus is no longer valid. Light bulbs are preferably changed every 2,000 hours as the irradiance of fluorescent light tends to diminish. Place the infant naked under the lights with shielding over the eyes. A small cloth may be placed for scrotum protection in male babies and the infant's position should be changed frequently.

The latest phototherapy units are based on the principle of fiberoptics. Here, an illuminated blanket is wrapped around the baby (Fig. 19.2).

Complications

- Insensible water loss
- Watery diarrhea
- Hypocalcemia in preterm infants
- Retinal damage
- Skin rash
- Bronze baby syndrome
- Hyperthermia.

Nursing Responsibilities

1. Check the lights of phototherapy unit before use and place.
2. Remove clothing to maintain proper skin exposure.
3. Turn frequently to expose all skin areas.
4. Temperature: Monitor infant's temperature frequently and sign of dehydration.
5. Eye care: Because of the potential eye damage, the eyes should be covered, while phototherapy is in use. Cover the eyes with pads without placing excessive pressure on the eyes and be carefully positioned to avoid occluding the nares. To permit evaluation of the infant's eyes, eye patches should be removed every 4 hours and changed every 8 hours.
6. Fluid balance: Close monitoring of daily weight, intake and output such as urine volume.



Fig. 19.2: Double surface phototherapy

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7. Cover genitalia.
8. Feeding: Advised to continue breastfeeding.
9. Observe common side effects of phototherapy, i.e. loose stools, skin rash or dehydration.
10. Overheating of surface should be avoided, because the local hyperthermia under the electrode can cause redness of the skin.



Fig. 19.3: Cold light source

COLD LIGHT SOURCE

Cold light source (Fig. 19.3) is a special light source without heat radiation. Keep the light source on a non-absorbent surface and avoid keeping over carpet or crib mattress.

Indications

1. Used to transilluminate the chest to detect pneumothorax, pneumopericardium and abdominal free air.
2. Transillumination is used to locate artery in arterial puncture and to locate peripheral vein in securing venous access.
3. Used for phototherapy, where both facilities are available, i.e. Biliblanket.

There are two popular models of cold light source available in the world market.

1. Biliblanket: It provides two features, a transilluminator and high output phototherapy system. It includes a soft fiberoptic pad, high-intensity lighting, an optional transilluminator, automatic shut-off, hour meter, adjustable light output and easily replaceable lamp.
2. Olympic medical Trans-Lite: It is a portable transilluminator and lightweight. It has two features, a transilluminator and phototherapy unit, which allows the baby to be cuddled without interruption and even nursed, while receiving phototherapy. The second which is lightweight, emits more light and less heat with adjustable intensity control.

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Procedure for Pneumothorax

Make the room darker for better visualization of hyperlucent areas. Place the transilluminator along the posterior axillary line on the suspected side and move up and down and above the nipple. Always transilluminate both sides for comparison.

Vessel Transillumination

To locate artery or vein for blood sampling or vessel cannulation.

Technique

In a dim lighted room, put sterile tip probe of high intensity fiberoptic light source, directly opposite to puncture site adjacent to vessel. Set light source at low intensity and increase as needed for visualization. Vessel is identified as dark linear structure with indistinct edges.

INCUBATOR

The incubators (Fig. 19.4) are essential to provide an ideal microenvironment for high-risk and low-birth weight babies. It can control temperature, humidity and oxygen concentration, while providing a high degree of isolation through the slight positive pressure maintained by air circulation system. These incubators are becoming less popular nowadays, as increased risk of nosocomial infection (humidity chamber is potential source of infection).

Two types of incubators are available:

1. The open box type (Armstrong) incubators are incapable of maintaining thermoneutrality due to alteration in temperature when lids are opened.
2. The intensive care or closed type (Isolette) incubators are equipped with portholes for access to the infants. These have effective thermostat and provision for entry of filtered air.



Fig. 19.4: Incubator

Parts of Incubator

1. Indicator light: Two white lights on the control panel,

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which indicates that the power is on and air circulation system is operating.
2. Temperature indicator meter: Provides continuous readings of the infant's temperature.
3. Thermostat knob: To obtain thermostat control of incubator air temperature.
4. Servo control probe: Is secured to the midline of the abdomen between the umbilicus and the xiphoid.
5. Thermometer: Indicate the temperature of the incubator.
6. Control point adjust button: The temperature control point of the infant servo control unit is fixed at 97°F (36.1°C). A temperature control point of 97°F or 36.1°C. Skin temperature is correlated with a body temperature of 98.5°F or 36.9°C.
7. Red line adjust button: Provides a quick means of checking the temperature meter for proper calibration.
8. Oxygen inlet: Source of oxygen flow should be connected to oxygen inlet.
9. Humidity chamber: It should be filled with sterile distilled water. The water should be drained and replenished daily to the level indicated by a black line. High humidity aids in relieving respiratory difficulty.
10. Portholes and plastic: For access to an infant, the porthole is opened/closed by turning the metal ring that surrounds the plastic sleeve counterclockwise/clockwise.
11. The plexiglass porthole is a lined plexiglass door located at the foot end of incubator through which contaminated linen and other articles may be removed.
12. Weighing facility: Vent at top portion of the plexiglass hood is used to facilitate weighing of the infant.
13. Storage cabinet: Base of the incubator provides storage area for individual linen and supplies.
14. Heater output monitor: Built-in heater output monitor provides information regarding the amount of heat generated by the incubator warmer.
15. Audiovisual alarm: Provided for set temperature, high temperature, air flow or probe failure.

Nursing Responsibilities

1. The incubator should be prewarmed to 34°C to 36.1°C for infants less than 1,500 g and 33.9°C to 35°C for infants more than 1,500 g.

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2. After the infant is placed the incubator is set for maintenance of skin temperature between 36.0°C and 36.5°C.
3. The servo control probe is in place and properly secured to prevent hyperthermia.
4. The weaning of infant from incubator should be gradual process.
5. The unit should be thoroughly disinfected every day.
6. Record temperature and humidity of the incubator and the responses of infant.
7. Do not open the incubator during the routine care.
8. Humidity chamber should be drained and replenished daily.

RADIANT WARMER

Radiant warmers (Fig. 19.5) are useful, especially during neonatal procedures and when infants are on ventilator, as infant loses body temperature. Infant is kept warm by radiant heat warmer. This heats the body in cold environment also. The infrared heat is preferable, because it directly warms the subject without affecting the temperature of intervening environment. Open care system is equipped with an overhead radiant warmer and skin thermistor with servo control and preferred over an Isolette incubator, because of easy access to infant and less chances of nosocomial infection.

1. Hood: Contains the radiant heat panel, will automatically turn on and off to maintain the infants temperature as desired by temperature control and thermistor attached to the infant.
2. Panels: There are four panels, two side panels, head and foot panel.
3. Bassinet procedure table: The bassinet may be placed in varying levels of position by squeezing the handle.
4. Storage area: Linen and equipment necessary for the individual care of infant may be stored here.
5. Control panel.
   a. Off-on switch: Turn the power on or off.
   b. Power light: Amber light illuminated when power is on.



Fig. 19.5: Radiant warmer

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c. Set temperature: Set the temperature between 36° C and 36.5° C, radiant energy is maintained at a level that will maintain the desired skin temperature.
d. Skin sensor probe: It is fixed to the abdominal skin midway between umbilicus and xiphisternum. The skin sensor feeds the information regarding temperature of the baby to thermostat, which automatically regulates the output of the heat to maintain desired skin temperature.

Method to Use Radiant Warmer

1. Switch on the radiant warmer to maintain thermoneutral environment.
2. Use air mode and adjust to thermal neutral environment.
3. Place the baby under the radiant warmer and change to servo control mode.
4. Dry and discard the wet sheet and fix the probe/sensor over abdomen in midline between umbilicus and xiphisternum.
5. Probe is appropriately fixed to baby's skin as loosely fixed probe may result in overheating and induce burns.
6. Set abdominal skin temperature (skin temperature at 37°C in skin servo mode or set air temperature at 35°C to 36°C in air servo mode).
7. Keep only the chest open for observation and cover the bassinet with sterile transparent polythene sheets.
8. Keep the stable babies wrapped in a sheet and monitor the vitals.

GLUCOMETER

Glucometer (Fig. 19.6) is a portable blood glucose monitor, which measure the blood glucose level from a drop of blood obtained from a finger prick or an alternate site. Also, it is useful equipment in emergency situations like hypoglycemia and hyperglycemia to measure the blood glucose level.



Fig. 19.6: Glucometer

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Mechanism

Reflectance Photometers

Plastic test strip is impregnated with chemicals, which react with glucose in the drop of blood. In the first generation glucometers, hydrogen peroxide is produced in the oxidation reaction between glucose and glucose oxidase. This changes color proportionate to the glucose concentration, which is measured photometrically.

Electrochemical Sensors

In newer generation of glucometers, an electrochemical cell is incorporated within the device. This measures the integrated current produced by the glucose oxidation reaction, a quantity that is proportional to the amount of glucose present.

Technique to Use a Glucometer

1. Turn on the glucometer and place a test strip in the machine when the machine is ready. Verify the code of the strip and the code on the meter. Watch the indicator for placing the blood to the strip.
2. Make sure the hand is dry and wipe the area selected with an alcohol and wait until the alcohol evaporates.
3. Pierce finger tip and obtain a drop of blood. To minimize discomfort or bruising, it may be of help to use the side of a finger, wash hands in warm water, shake the hands or use finer-tipped lancets.
4. Place the drop of blood on or at the side of the strip.
5. Glucometer will take a few seconds to display the reading.

PULSE OXIMETER

The pulse oximeter (Fig. 19.7) record light transmission through pulsating arteries only and measures the arterial blood oxygen saturation. Hemoglobin is photosensitive and has the capacity to absorb different amounts of light. Changes in



Fig. 19.7: Pulse oximeter

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oxygen levels can be rapidly detected by oximetry. When hemoglobin is well saturated with oxygen, it is red in color and has the capacity to absorb more light from the red and infrared probe on a saturation monitor; when hemoglobin has a lower oxygen concentration, the blood changes to a blue color and the amount of light absorbed from the red and infrared light that passes through the skin is less. The probes work by placing the light-emitting part on the top of one part of the body (e.g. a finger) and the photodetector directly opposite the light source, underneath of finger. The light emitted from the probe has red and infrared light, which passes directly through the skin, enabling it to be interpreted by the photodetector. Oxygenated blood absorbs light at 660 nm (red light), whereas deoxygenated blood absorbs light preferentially at 940 nm (infrared). Pulse oximeters consist of two light-emitting diodes, at 600 nm and 940 nm and two light-collecting sensors, which measure the amount of red and infrared light emerging from tissues traversed by the light rays. The relative absorption of light by oxyhemoglobin (HbO_2) and deoxyhemoglobin is processed by the device and an oxygen saturation level is displayed.

Pulse oximetry offers several advantages over conventional arterial blood gases for monitoring arterial O_2 saturation.

- More accurate determination of arterial O_2 saturation
- Superior detection of hypoxic episode
- Non-invasive and less expensive.

RESPIRATORY RATE AND APNEA MONITOR

The respiratory monitor based on impedance technique measures changes in the electrical resistance during breathing. The electrode is fixed on the chest wall to pick up signals, which are digitally displayed as respiratory rate. The conventional apnea monitors (Fig. 19.8) are based on air mattress having plethysmographic sensor. The mattress is placed underneath the chest of the infant and mechanical alteration produced by respiratory movements of the infant are recorded and displayed. Alarm is set for 10, 15 and 20 seconds.

PEAK FLOW METERS

Peak flow meters (PFM) (Fig. 19.9) are handy instruments useful for monitoring lung functions. They usually document the changes of

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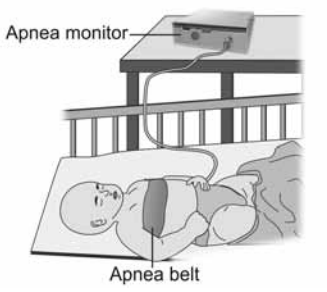

Fig. 19.8: Apnea monitor

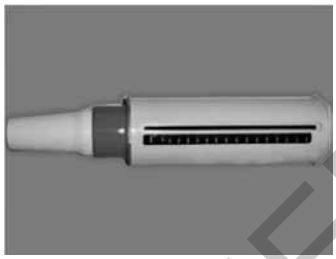

Fig. 19.9: Peak flow meter

forced expiratory flow through medium and large airways. They are available in two ranges:

- Low range (< 350 L/min) for use in younger children
- High range (< 800 L/min for use in older age groups)
- Children above the age of 5 years can be taught to use them.

Utilities

- Early recognition of an impending attack of asthma
- Response to therapy following an acute attack
- Long-term monitoring of chronic asthma
- Home management of early asthma attack
- Child with 'difficult to control' asthma.

Method to Use the Peak Flow Meters

1. Fix the clean mouth piece to the meter.
2. Bring the pointer to zero.
3. Let the child stand up and hold the peak flow meter horizontally without restricting the movement of the pointer.
4. Place the mouth piece in the child's mouth and let him purse his lips snugly around the mouth piece.
5. Instruct the child to breathe in as deep as possible. Let him blow out as hard and as fast as possible.
6. Record the values, consider the best of three readings.

Concept of Personal Best

Personal best is taken as the baseline reference point for that child. In the absence of personal best values, the formula of '100 cm equals

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100 liters' with increments of 50 liters for every 10 cm height can be used.

Limitations

- Peak flow meter cannot be used in children below 5 years of age
- It does not adequately document the changes in small airway caliber.

INFUSION PUMPS

The infusion pump (Fig. 19.10) is an electronic micropump, which displaces fluid and a microprocessor or pressure transducer controls the rate of fluid delivery. The rate of infusion is either depicted as drops/minute (1–99 drops/minute) or in term of volume (1.0–99.9 mL/h) through a disposable plastic syringe. The use of pumps to deliver fluids and medications in pediatrics is a necessity.

Indications

Delivering small volumes of fluids accurately, administering vasoactive and other drugs either continuously or intermittently and maintain the patency of central venous and arterial catheters.

There are two basic types of pumps: Volumetric infusion pumps and syringe pumps.

Volumetric Pumps

Volumetric pumps are used for infusing large volumes of fluids from a bag or bottle of intravenous fluid. Most of these use a peristaltic mechanism, whereby fluid is pumped by a series of rollers that sequentially compress the intravenous tubing, because this results in fluid being delivered in mini-boluses rather than continuously. Volumetric pumps usually deliver fluids at rates from 0.1 to 999 mL/h.

Syringe Pumps

Syringe pumps (Fig. 19.10) are used for precisely delivering small volume of drugs from a syringe. They are used exten-



Fig. 19.10: Syringe pump

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Practical Aspects of Pediatrics and Neonatology for Nurses is an extremely thorough and comprehensive textbook. It presents the essential concepts that the nursing students need to know about the neonatal and pediatric procedures and their application. Also, it is designed to assist the nursing students in developing expertise and in-depth understanding in the field of pediatric nursing. This book gives instructions on the common nursing procedures. It will help the students develop advanced skills for nursing intervention in various pediatric conditions and enable them to function as pediatric nurse practitioners. The book is packed with clear pictures and diagrams to complement the concise and easy-to-read text. It also provides clear coverage of the scientific and clinical knowledge of nursing for delivering safe and effective care.



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