

Review Article :

Infection control protocol in NICU suitable for a peripheral newborn care unit

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Abstract:

Newborn care is one of the vital sectors to be looked into in order to reduce neonatal mortality and morbidity. Infection is a great area of concern, especially for preterm babies. We are losing many babies, because of sepsis in resource limited settings. While it is difficult to treat neonatal sepsis, it is rather easier to prevent infections. Recommendations for prevention of neonatal sepsis is presented, with special reference to the rural Indian scenario. The approach towards the prevention of neonatal sepsis is multi-disciplinary, comprising of neonatologists, hospital administrators, nursing staff and engineers. Thus making implementations easy. If the equipment and other consumables are manufactured indigenously in bulk, and in large quantities, the cost is bound to come down significantly. Thus, reducing the financial burden on the hospitals and the health-care cost of the country

Introduction:

With the Make in India initiative by the Govt. of India, neonatal care should see a paradigm shift. The present system of purely conservative approach must shift to high end professional and preventive approach towards the management of neonatal cases, as cost of equipment both consumables and non-consumables are likely to come down across the board. Effective means of infection control in NICU can be established, once the journey of a microbe from the environment to

the susceptible infant is understood. The microbes enter the NICU via visitors and health care workers (HCW'S) and proliferate in susceptible sites. They are spread to the neonate via contaminated equipment and contaminated hands of the HCWs. Once the babies are colonized, the organisms then enter through their umbilical cord and skin during procedures such as venous access, parenteral fluids, enteral feeds, intubation and suctioning of endotracheal tube.

Infection control Step I :

Prevent entry of microbes into the NICU¹

a. Clean immediate environment:

Organisms from labor room, resuscitation room environment and maternal vaginal flora can colonize the newborn skin. This can be prevented by following the 6 C's: (1)Clean perineum, (2)Clean delivery surface, (3)Clean cord and (4)Cutting instrument, (5)Clean cord care, and (6)Ensuring that nothing unclean is introduced into vagina. Equipments for resuscitation in well baby area should be cleaned and regularly autoclaved.

b. Standardize the NICU design²:

i. Location of NICU: The NICU has a distinct area with controlled access. Each infant space has a minimum of 120 sq ft clear floor space excluding the hand washing areas and corridors. There should be a minimum of 4 ft between two infant beds.

ii. Airborne infection isolation room: An airborne infection isolation room should be available. A hands free hand washing station for hand hygiene and areas for gowning and storage of clean material should be provided near the entrance to the room. Ventilation has negative air pressure with exhaust to the exterior. When not used for isolation, these rooms may be used for care of non-infectious infants. Relative humidity should be 30-60% Humidity > 60% may promote growth of micro organisms. According to American Institute of Architecture (AIA) guideline, the NICU should have a minimum of 6 Air change per Hour (ACH) and 12 ACH for isolation room.

iii. Hand washing station: Every infant bed should be within 20 feet of a hands free hand washing station. The hand washing sink should be large enough to control splashing. Pictorial hand washing instruction should be provided. Non absorbent wall material should be used around the sink to prevent the growth of mould on cellulose materials. There should be space for soap and towel dispensers.

c. Hand hygiene^{3,4}

CDC recommends hand washing before and after contact with every patient for 20 seconds and 40-60 seconds of hand washing before entering the NICU. Step-by-step hand washing should be done as follows. All accessories removed (No watch, No bracelet, No rings on the fingers) → Turn on water, wet hands, and apply antimicrobial soap → Rubbing palm to palm → Rubbing palm over dorsum → Rubbing fingers interlaced → Rubbing back of fingers → Rotational rubbing of thumbs → Rubbing wrist → Rubbing forearm → Rinse under running water → Turn off water without contamination → Wet hands dry with paper towel wipe hands in fingertip to wrist direction → Discard used paper in a garbage bin. Each of these actions must be done for a minimum of 5 seconds, taking a total of 30 seconds.

d. Use of alcohol—base hand rubs (ABHR)

Alcohol-based hand rubs can be used as hand hygiene agents if hands are not visibly dirty or contaminated. They are proven to be more effective than standard hand washing. Alcohol rubs may be used in between patient examination. At least 2-3 ml hand rub should be applied to all over surface of palm and fingers. ABHR are not useful after touching an infected patient or when the hands are soiled.

e. Visitors' policy / Mobile restriction

Usually microbes enter into NICU through personnel who enter into NICU and hence restriction of entry is a must. People with active infection (Respiratory, muco-cutaneous and gastrointestinal) and children should not be allowed inside NICU. Infected and out born infants should be managed in the isolation room. NICU should be a cell phone free zone.

f. Gowning to reduce nosocomial infection

Studies have shown no reduction of infection during gowning period as compared to no gowning period. The focus should be on adequate hand washing by all hospital personnel and visitors before handling neonate.

g. Jewelry and fingernails Policy

Consensus recommendations are that health care workers should not wear artificial fingernails or extenders when having direct contact with patients and natural nails should be kept short (0.5 cm long or approximately ¼ inch long)

Infection control step II

Prevent proliferation of microbes in the NICU

Good housekeeping routines are helpful in reducing the proliferation of microbes, thus preventing and curtailing spread of infection. Avoid wet areas inside the NICU. Dry and clean NICU is unlikely to harbor microbes. The details of the housekeeping routines and the waste disposal are described in a tabular form.

Table 1: Daily and weekly routines in NICU

Daily	
Incubators, warmers, syringe pump, infusion pumps, phototherapy units, Mattress, Pulse oximeter, multichannel monitors, Oxygen hood, Ventilator, CPAP machine, Telephone	Dry dusting, clean using a moist wipe
Suction bottles, Humidifier chamber, water in Bubble CPAP	Change with distilled water
Ventilator filters	Clean daily and dust off
Bag and mask	Immerse in 2% cidex for 6 to 8 hours after dismantling and cleaning with running water.
Incubators / Radiant warmers	Clean with 2% Bacillocid if not occupied by an infant.
Laryngoscopes, masks, stethoscopes, measuring tapes, Thermometer, BP cuff, temperature and Spo2 probes, Torches	Wipe with spirit
Walls, floor, Wash basins	Clean with polysan or phenol or Lysol or 2% bacillocid or 0.5% chlorine (for walls only) in each shift
Dust bins, buckets, waste	Empty during each shift and clean with soap and water
Weekly	
Ventilator and CPAP circuits	Change with a new circuit
Procedure sets	Autoclave after every use and keep ready the sets
Window Air-conditioners	Surfaces and filters with soap and water
Refrigerators	Sorted and cleaned separate fridge for milk and lab samples
Thermometer, weighing scale, stethoscopes, BP cuff, laryngoscopes should be cleaned and wiped with spirit after every use. Feeding utensils/ paladai should be boiled for 15 minutes after cleaning after each use.	
Waste disposal	
Black drums (waste disposal by dumping)	Left-over food, vegetables, waste paper, packing material, empty bags etc
Yellow drums (disposed by incineration)	Infected non plastic waste- human secreta, blood and body fluids.
Blue drums (made noninfectious by autoclaving and disposed by shredding)	Infected plastic waste like IV sets, ET tubes, catheters, urobags etc

Infection control STEPIII:

Preventing infection spread from proliferation sites to baby and from one baby to other

This is the most important step in preventing the spread of microbes from proliferative sites to baby and from one baby to another baby (Cross Contamination). The following steps are important in this regard.

a. Nurse to patient ratio:

All units undertaking neonatal intensive and high-dependency care should have appropriate number of neonatal nurses. Recommended ratio is 1:1 if baby has multidrug resistant microbes, 1:2 if babies are having similar organism or susceptible organism, 1:3 if babies are already on adequate antibiotics cover.

b. Use Disposables:

To break the journey of microbes, ample disposables are needed. A baby kit containing stethoscope, measuring tape, thermometer and a torch in a sterile container should be available at each bed. There should be separate syringe for each medication and for each baby. Each time, a fresh suction catheter should be used for endotracheal suction.. For each baby separate gloves, antibiotics vials, disposable respiratory support circuits, should be used. Do not keep formites e.g. files, x-ray films, and pens on the baby cot. For flushing of catheter, stock solution should not be used. Epidemic of *Enterobacter cloacae* in the NICU with use of multi dose antibiotic vials has been reported.¹

c. Laminar flow system for drugs, fluids and TPN preparation:

Use of laminar flow for preparation of TPN and other IV. Fluids decreases local complication rate (thrombophlebitis, gangrene, and abscess) and sepsis.

Infection Control Step IV:

Prevent entry of microbes into the infant⁵

Once microbes colonize the skin and umbilical cord, they enter the circulation if there s any breach in aseptic precautions. Hence proper hygiene the during procedures is crucial.

a. Cord care:

Cord infections can be prevented through promoting clean cord care and reducing harmful cord applications. The WHO currently recommends dry cord care in developing countries and the use of soap and water solution to clean the cord if visibly soiled

b. Skin care:

Skin injury should be prevented by applying less adhesive tape, using Tegaderm between skin and adhesive, precaution during adhesive removal and by using skin friendly Duro pore instead of Dynaplast and Micropore. Bath should be avoided in hospitals, instead sponiging may be done.

c. Precautions during procedures:

Aseptic precaution should be taken during all procedure. Hand scrub to be done prior to each procedure. Skin area should be cleaned with spirit, betadine and then again with spirit wipes. Disposable gloves should be worn. After insertion, cannula should be fixed with a transparent tape. The cannulation site should be monitored daily for signs of thrombophlebitis. In neonate, short catheter should be changed only when clinically indicated. Catheter insertion in emergency conditions increases the risk of non-compliance to the insertion protocol and, these catheters must be removed as soon as the patient's condition is stabilized.

d. Precautions during CVC/PICC/ Umbilical catheter/ Handling of catheter:

- I.** Training and education of health-care workers.
- ii.** Observe proper hand-hygiene procedures.
- iii.** Always allow povidone iodine to remain on the skin for at least 2 min prior to insertion.
- iv.** Wear Sterile gloves

- v. Use either sterile gauze or sterile transparent, semi permeable dressing to cover the catheter site.
 - vi. Monitor the catheter sites visually or by palpation through the intact dressing.
 - vii. Replace catheter-site dressing if the dressing becomes damp, loosened, or visibly soiled.
 - viii. Promptly remove any intravascular catheter that is no longer essential.
 - ix. Leave PICC in place until IV therapy is completed, unless evidence of complications (e.g. phlebitis and infiltration) occurs.
 - x. Change tubes and bottle every 24 hours taking same precautions as used for inserting central line i.e. surgical scrub, mask, gown, gloves, and a sterile dressing set.
 - xi. Remove and do not replace umbilical artery catheter if any signs of catheter related blood stream infections (CRBSI), vascular insufficiency, or thrombosis are present.
 - xii. Optimally, umbilical artery catheters should not be left in place >5 days
 - xiii. Umbilical venous catheters should be removed as soon as possible when no longer needed but can be used up to 14 days if managed aseptically.
- e. Precautions during endotracheal intubation and suction**
- i. Wear face mask, do surgical scrub, wear autoclaved gown, wear sterile gloves, take the help of a nurse.
 - ii. Endotracheal tube should stay in the sterile pack till the point of use.
 - iii. Don't touch tracheal tip of the tube.
 - iv. Wear sterile gloves for suction.
 - v. First tracheal suction should be done then mouth,
 - vi. Discard suction catheter after a single use,

- vii. Take the help of a nurse for instilling saline (when needed) or disconnecting the ventilator.

Infection control step V:

Breastmilk/Breastfeeding and Correct preparation of Formula Milk (when indicated)⁶

It is important to support breastfeeding and promote its benefits to infants and young children. Encourage use of colostrums, trophic feeds with expressed breastmilk and non nutritive sucking by the infant. Mother's entry into the NICU and pumping of milk to ensure adequate adequate breastmilk for the infant may be encouraged. However if the infant needs formula feed, the FAO/WHO expert working groups (2004 & 2006) recommend that temperature of water should not be less than 70 0 C at the Point of reconstitution of formula and a decrease in the holding and feeding times would effectively reduce risk of contamination. If the formula is prepared in advance, it should be refrigerated to below 50 C but not for more than 24 hour Re-waring should be done immediately before feeding. Feeds should not be left warming for more than 15 minutes.

Infection Control Step VI:

Kangaroo Mother Care/Early discharge

In the Cochrane meta-analysis of stabilized LBW infants, KMC was associated with a statistically significant reduction in severe infection/sepsis at latest follow-up (7.2% versus 12.6%; RR 0.57, 95% CI 0.40-0.80), nosocomial infection/sepsis at discharge or at 40-41 weeks corrected restational age (4.2% versus 10.1%; typical RR 0.42, 95% CI 0.24-0.73).⁷

Infection Control step VII:

Decreasing susceptibility of the baby to infections

a. Early breast feeding / Use of colostrums / Minimal Enteral Nutrition:

Numerous studies have linked own mother's milk and colostrums feedings with a lower

incidence and severity of nosocomial infection or late-onset sepsis in premature (<37 weeks gestation) infants. Trophic feeding has benefits which include improved milk tolerance, greater postnatal growth, reduced systemic sepsis and shorter hospital stay.

b. Immunomodulators:

Current evidence does not support the use of IVIG and GM-CSF for prevention of nosocomial infections. The role of probiotics is promising but the right choice, the right dose and the right patient is still under review.

c. Antifungal prophylaxis:

Antifungal prophylaxis is recommended for all Extreme Low Birth Weight babies. The Cochrane meta-analysis suggests that there will be one fewer death in every nine infants treated with this intervention but 95% confidence interval around this estimate of effect is wide. Future large Randomized controlled trials are needed.

Infection Control step VIII :

Infection Control protocols⁸

Prevention of nosocomial infections is the prime responsibility of all individuals. Everyone must work cooperating with each other in order to reduce the risk of infection for patients and staff. Therefore, infection control protocols should be in place.

a. Role of hospital management:

The role is to establish a multidisciplinary infection Control committee who can use appropriate resources and methods to monitor and prevent infections, ensure education and training and participate in outbreak investigation. The physician, microbiologist, nursing manager, resident nurses and housekeeping staff must play their role in infection surveillance and prevention of infection outbreaks in NICU.

b. Infection Control Committee:

Hospital should have an infection control

committee in place with the goals to review and approve promptly:

1. A yearly programme of activity for surveillance and prevention.
2. Epidemiological surveillance data and identify areas for interventions.
3. Ensure appropriate staff training in infection control and safety.
4. Provide inputs into investigation of epidemics.

c. Antibiotic usage and microbial resistance:

- i. The hospital must have an antibiotics policy depending upon the local conditions.
- ii. Antimicrobial resistance has emerged as a major public health issue all over the world, especially in developing countries like India.
- iii. Prophylactic antibiotics should not be started in conditions like severe asphyxia, neonatal jaundice, prematurity, caesarean delivery and exchange transfusion.
- iv. Without exception, a blood culture should be obtained before starting an antibiotic.
- v. If the blood culture is sterile after 48-72 h of incubation, it is almost always safe and appropriate to stop antibiotics.
- vi. Restrict the use of broad spectrum antibiotics, for empiric therapy. Narrow spectrum antibiotics should be chosen, CRP should not be a guide for antibiotic therapy. Shorten the duration of antibiotic administration, whenever possible.
- vii. Use of cephalosporins, quinolones and carbapenems should be restricted to microbes resistant to aminoglycosides of penicillins. In a recent study, cephalosporian restriction reduces the incidence of ESBL producing bacteria from 46.8% to 19.5%.⁹
- viii. Antibiotics stewardship (ASPs): Antibiotic

stewardship is a multisystem team approach that involves limiting inappropriate use of antibiotic agents while optimizing the selection, dose, duration and route of therapy with the most appropriate drug for the patient's condition. ASPs have been associated with 22-36% reductions in antibiotic use and are associated with numerous clinical benefits.

- ix. Treat the infection, not colonization or contamination.

Conclusion :

The morbidity and mortality of neonate can be significantly reduced by instituting strict infection control strategies. Prevention of entry of microbes to NICU can be achieved by clean environment, hand hygiene and conducive infrastructure. Curtailing proliferation of microbes in NICU can be successful by daily and weekly maintenance of equipments like incubators, warmers, syringe pumps, ventilator filters, circuits, bag and mask. Efficient bio-medical waste disposal is very important. Cord care, skin care and precautions during various procedures like venepuncture, endotracheal intubation and umbilical catheterization are important. Early breast feeding, use of colostrums and early discharge play an important role in prevention of neonatal morbidity. The role of hospital management and a robust infection control committee play an important role in prevention of infection related neonatal morbidity and mortality.

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