



NEST-ED

Clinical Modules

June 2020

Newborn Essential Solutions and Technologies-Education (NEST-ED) Clinical Modules provide educational support for each of the technologies included in the NEST360 bundle for newborn care. These materials are intended to strengthen locally developed neonatal and technical trainings in pre-and in-service settings and are not intended to be comprehensive clinical guidelines or targeted towards intensive care of the newborn.

**FACILITATING THE CLINICAL USE OF
TECHNOLOGIES FOR NEWBORN CARE IN LOW-
RESOURCE SETTINGS**

DISCLAIMER

Newborn Essential Solutions and Technologies-Education
Clinical Modules: Infection Prevention and Control

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In addition, all forms, instructions, checklists, guidelines, and examples are intended as resources to be used and adapted to meet national and local health care settings' needs and requirements.

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PREFACE

This series has been designed with the intent of supporting the clinical use of technologies in newborn care units.

Newborn Essential Solutions and Technologies-Education (**NEST-ED**) Clinical Modules provide educational support for each of the technologies included in the NEST360 bundle for newborn care. These materials are intended to strengthen locally developed neonatal and technical trainings in pre- and in-service settings. Of note, these materials are not intended to be comprehensive clinical guidelines or targeted towards intensive care of the newborn. They are to be used to facilitate the implementation of comprehensive newborn care, including bubble CPAP, in a resource limited setting.

The NEST-ED Clinical Modules were developed through a combination of international standard review, international expert feedback, and multinational NEST360 expert consensus opinion. NEST-ED Modules form the backbone of all lectures, power points, job aids, and other supportive education materials supplied by NEST360.

**THIS IS ONE MODULE IN A SERIES OF NEST-ED
CLINICAL & TECHNICAL MODULES AVAILABLE.**

To view the full series, visit the [NEST360 Resources](#) website.

ABBREVIATIONS

ABC	Airway, Breathing, Circulation
bCPAP	Bubble continuous positive airway pressure
dL	Decilitre
FiO₂	Increased Fractional Concentration of Oxygen
Fr	French size
HAI	Hospital acquired infections
HCWs	Healthcare workers
HFNC	High flow nasal cannula
IV	Intravenous
KMC	Kangaroo mother care
LBW	Low birth weight
LCD	Liquid crystal display
LED	Light emitting diode
mm Hg	Millimeters of mercury
NEST360	Newborn Essential Solutions and Technologies
NEST-ED	Newborn Essential Solutions and Technologies-Education
NGT	Nasogastric tube
nm	Nanometer
O₂	Oxygen
OGT	Orogastric tube
ppm	Parts per million
ROP	Retinopathy of Prematurity
SpO₂	Peripheral blood oxygen saturation
UPS	Uninterruptible power supply
WASH	Water, sanitation and hygiene
WHO	World Health Organization
wks	Weeks

NOMENCLATURE

bCPAP prongs	bCPAP patient interface
Cot	Bassinet, infant crib
Christmas tree nozzle	Barbed oxygen fitting, nipple and nut adapter
Flow splitter	Oxygen splitter, flow meter stand
Glucometer	Glucose meter
Hospital Acquired Infection	Iatrogenic infection, nosocomial infection
Nasal prongs	Oxygen catheter, oxygen cannula, oxygen prongs
Positive Pressure	Positive end expiratory pressure, positive airway pressure
Radiant warmer	Resuscitaire, resuscitation table
Suction pump	Suction machine

Introduction

This NEST-ED Clinical Module has been prepared to help healthcare staff & students understand when & how to apply infection prevention measures in newborn care. This is one module in a series of NEST-ED Clinical and Technical modules available that may be used by teaching institutions to supplement current newborn care curricula or by hospitals, clinical departments, and individuals to update their knowledge and to better facilitate the effective and safe use of newborn care equipment.

Whilst reading this series, navigate to the [Table of Contents](#) by clicking the NEST360 logo that appears at the bottom right corner of each page: **NEST360°**

Every module has a similar structure with sections and subsections. The sections have similar headings and subheadings to make it easy for the user to navigate them. However, words may have different meanings for the various cadres of staff reading them and so to reduce misinterpretation, the heading titles are explained below.

An exception to this structure is the **Infection Prevention & Control: General Infection Prevention** module. This module describes general infection prevention measures in relation to the use of equipment in the ward. There are also sections on reprocessing of single use items and a useful table of suitable disinfectants.

CLINICAL PROBLEM

This describes the situations in which a piece of equipment may be clinically useful. It does not include all the clinical background in making that decision, as this should be covered in country-specific neonatal care protocols & clinical training materials.

ASSESSMENT

This section explains how a piece of equipment works, as well as how it may be useful in certain patient care settings (e.g., why an overhead radiant heater is useful for short term warming in the labour ward while resuscitating a newborn).

MANAGEMENT

Step by step preparation for setting up, checking, and using the equipment is described. This is followed by explanations of how to remove the equipment from a baby when it is no longer needed, how to clean it, and how to store it safely until further need.

INFECTION PREVENTION

In this section infection prevention measures are described for the equipment when in use, followed by instructions on how to disinfect the equipment both during and after use.

COMPLICATIONS

The complications described in this section are those relating to the use of the equipment and do not include all clinical complications that may arise from underlying medical problems. These are beyond the scope of the modules and should be covered in clinical training materials.

CARE & MAINTENANCE

Advice is given on where to place equipment for use, how to safely handle such devices and their consumables, and how to keep them functioning well by using preventive maintenance measures.

TROUBLESHOOTING & REPAIR

This section provides helpful advice on what to check if equipment is malfunctioning on the ward. It is intended to help healthcare staff deal with minor technical difficulties for which there are simple remedies. Detailed machine maintenance is beyond the scope of these modules and is covered in the technical modules that accompany these clinical ones.

ASSESSMENT QUESTIONS

A few questions are attached based on module content. These may be used, for example, during mentoring visits or to emphasise some of the points raised in teaching with the module.

REFERENCES & ALERTS

References and alert boxes are included within each module to provide clarity on areas where recommendations are governed by published standards, evidence, and/or expert opinion. This is included for the dual purpose of facilitating (1) feedback and continuous improvement of NEST-ED Education Modules and (2) implementer review of content for incorporation in local trainings.



ALERT 0.0 Subject

QUERY ALERT BOXES appear where there may be controversy or disagreement. In these cases, alert boxes provide background to the recommendations that are made in the body of the document. Relevant documents are cited and brief explanation of reasoning for current module content provided.

ALERT 0.0



RECOMMENDATION ALERT BOXES appear where there are recommendations based largely on expert opinion or consensus, or to emphasize an important element of care. Relevant documents are cited and brief explanation of reasoning for current module content provided.

Infection Prevention & Control

General Infection Prevention

1 Introduction

Introduction of essential devices to newborn care units is critical to improving newborn survival. However, devices can increase hospital acquired infections if adequate disinfection and cleaning measures are not put into place.

This module focuses on infection control measures associated specifically with the essential devices, staff and visitors. A comprehensive discussion of infection prevention and control measures for a newborn care unit is beyond the scope of this document. Please refer to local and WHO guidelines for more detailed practice guidance.

2 Ward Infection Prevention

Hospitals, wards, equipment and staff are all sources of infection for a baby. These infections are called Hospital Acquired Infections (HAI).

HAIs are often caused by bacteria that are resistant to commonly available antibiotics - multidrug resistant bacteria - and are difficult to treat or eradicate from the nursery. Meticulous care is required to prevent infections from spreading from one baby to another in the ward. The prevention and control of all infections include:

- Hand hygiene
- Environmental cleanliness
- Medical equipment maintenance and cleaning
- Waste disposal

Water, Sanitation and Hygiene (**WASH**) are key elements in preventing and controlling infections.¹

Infections are a major cause of morbidity and increased mortality. They often result in prolonged hospital stays and increased costs to the family. Sick and small neonates are at higher risk than other patients of acquiring HAIs due to the number of devices they may come into contact with in neonatal units. Lowering rates of HAIs means less use of antibiotics and ultimately fewer infections with multidrug resistant bacteria which are very difficult to treat in newborns.

While there are a number of critical elements associated with infection prevention and control in newborn units that will be discussed here, the **two most important** forms of infection control are always **hand washing** and **health screening**.

HANDWASHING

Hand hygiene is the **single most important** measure to reduce transmitting infections between people and from one site to another on the same patient. All guardians, health care workers (HCWs), or visitors should be taught thorough handwashing (using the WHO technique).

- When entering a unit all HCWs and guardians must thoroughly wash their hands and arms up to the elbow with soap and water. Hands should be air-dried or dried using single-use towels that are then washed, dried and ironed before reuse.
- Hands should be washed whenever visibly soiled. Otherwise alcohol-based hand sanitiser is acceptable.

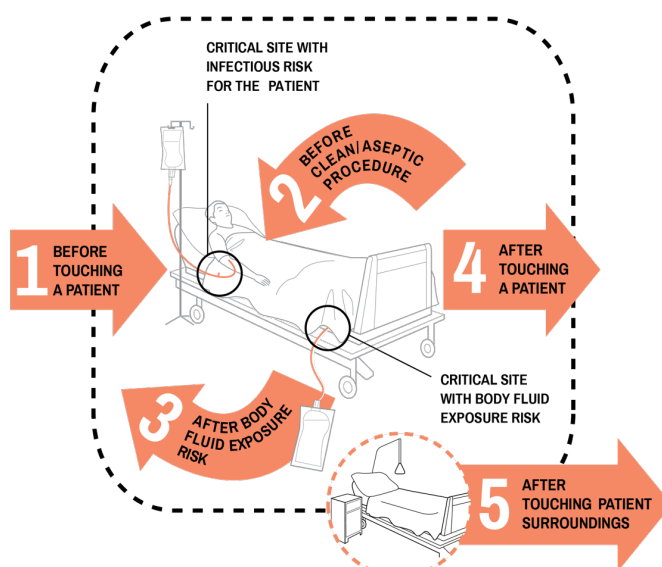
Hand washing or sanitising should be the **last** thing you do before touching a patient and the **first** thing you do after completing tasks on a patient.

GLOVES

Gloves are worn to protect **both** HCWs and patients by reducing the spread of infection from bacteria on the hands. Gloves **do not** change the need to wash or sanitise one's hands between patient interactions. Gloves should be worn **only when necessary and disposed of immediately after use**, such as when:

- Touching bodily fluids, non-intact skin, and mucous membranes.
- Performing invasive procedures.
- Touching contaminated objects or surfaces.

Repeat hand washing or sanitising promptly after removing gloves.



2.1 WHO 5 Moments for Hand Hygiene.

DRESS CODE

All hospital staff (including HCWs, maintenance and cleaning staff) should wear clean clothes with bare arms below the elbow when entering the neonatal ward. Department policy should be followed; this usually includes that no jewellery (apart from plain wedding bands) is worn, and that nails are kept short, natural, and unvarnished.

Gowns are not a standard precaution for HCWs or families in most neonatal units; if gowns are used, they should not be shared or reused until re-washed.

HEALTH SCREENING

Any HCW or guardian with an acute or transmissible infection should not be on the ward to minimise the spread of infection. Mothers or guardians who have an acute illness should be isolated with their infants, if possible. Any guardian who has an acute respiratory illness should wear a mask and be especially careful about hand washing.

3 Environment

PATIENT ISOLATION

Departmental isolation policies should cohort at-risk patients with similar infections in an isolation area within the nursery (e.g., babies with multi-drug resistant infections, highly contagious infections, babies born before arrival with signs of infection or any patients with airborne infections). Strict hand hygiene measures should be followed on entry and exit from this area. If equipment is used in any areas where patients are isolated, it should not be returned to the main neonatal care ward until it has been thoroughly cleaned and disinfected according to ward protocol.

Patients should not share cots or radiant warmers. If circumstances mandate that such a practice is unavoidable, cohorting patients with similar illnesses is preferred.

EQUIPMENT CLEANING

All neonatal medical equipment (suctions, CPAP, vital sign monitors, radiant warmers, etc.) should be cleaned regularly in accordance with the training modules and equipment manuals. WHO recommends 0.5% dilution of chlorine as the standard disinfectant for materials and surfaces contaminated by blood or body fluids.² For metal and rubber surfaces which may be corroded by

chlorine, 70% alcohol is also commonly utilised for low level disinfection. **Table 3.1** below provides more information on low-level disinfectants appropriate for neonatal wards.³ Cleaning should be carried out when the equipment power source is switched off and it is unplugged. Care must be taken not to let water or other liquid enter internal to a device. Diluted disinfectants have various lifespans; ward guidelines should include accurate lifespans and dilution schedules for those in standard of practice.

TABLE 3.1 CLEANING SOLUTIONS

Disinfectant Common Name	Recommended Use	User & Equipment Precautions
Sodium Hypochlorite, 0.5% or 1% liquid bleach	General disinfectant Kills bacteria, fungi, mycobacteria, spores & viruses Not affected by hard water (e.g., high mineral content water) Use 0.5% concentration for disinfection of surfaces & equipment contaminated with blood and body fluids	Use in well-ventilated area Respiratory irritant (can cause breathing problems) Appropriate PPE required while handling & using because it can cause skin irritation and burns Should not be mixed with strong acids or ammonia to avoid release of chlorine gas
Alcohol, 70% isopropyl, ethyl alcohol, surgical spirit	Use on smooth surfaces, table tops, aprons & other small surfaces on which bleach cannot be used (e.g., metal, rubber) Can be used for surfaces including rubber stoppers on medication vials Does not leave residue	Use in well ventilated area and avoid inhalation Keep away from active heat sources, electrical equipment, flames, hot surfaces. Alcohol must always completely dry on equipment prior to use as otherwise it could result in fire. Allow to dry completely before using area
Quaternary ammonium compound listed as % concentration of QUAT on different cleaning solutions	General disinfectant for surfaces/equipment contaminated with blood & body fluids Kills bacteria, fungi and some enveloped viruses (HIV) Has persistent antimicrobial activity when undisturbed	Use in correct dilution and pour only enough for current use Does not kill spores, TB or non-enveloped viruses Hard water, cotton/gauze, organic matter reduce its effectiveness
Iodophor	More commonly used as an antiseptic than a disinfectant	Causes damage to silicone catheters
Improved hydrogen peroxide	General disinfectant for surfaces or equipment contaminated with blood & body fluids Unaffected by organic matter Non-corrosive & safe for workers	Can be expensive, particularly if purchasing large quantities
 Phenolic germicidal detergent Dettol, Triclosan	Should not be used in neonatal wards since affordable, effective alternatives are available	May cause hyperbilirubinemia and/or neurotoxicity in neonates ⁴

Bleach is one of the most common substances used to disinfect medical devices. **Diluted bleach solutions have a lifespan of 24 hours and should be prepared daily.** Possible products are presented in **Table 3.2** with appropriate ratios to dilute to a 5% solution.

TABLE 3.2 BLEACH PREPARATION

Product	% Chlorine Available	Diluting to 5% Solution
Sodium Hypochlorite liquid bleach	5.25 - 6.15%	1-part bleach to 9 parts clean water RATIO [1 : 9]
Sodium Hypochlorite liquid bleach	3.5%	1-part bleach to 6 parts clean water RATIO [1 : 6]
NaDCC (Sodium Dichloroisocyanurate) Powder	60%	8.5 grams to 1-liter clean water RATIO [8.5 g : 1 L]
NaDCC, 1.5 g/tablet tablet	60%	6 tablets to 1-liter clean water RATIO [6 tablets : 1 L]

ROUTINE CLEANING

All horizontal surfaces, including bedside equipment (bed rails, bedside tables, trolleys, commodes, taps, weighing scales, etc.) are cleaned and disinfected with a hospital-approved detergent OR disinfectant such as 0.5% chlorine or 70% alcohol solution **at least daily** and whenever visibly soiled.

Between patient admissions, all cots and patient beds should be cleaned thoroughly (including all surfaces of incubators) with a hospital-approved detergent/disinfectant such as 0.5% chlorine or 70% alcohol solution.

Floors, surfaces, and handles in the neonatal unit should be cleaned daily with appropriate solutions and according to departmental policy.

SAFE HANDLING OF SHARPS

To prevent injuries, use extreme caution when handling sharps. This is particularly pertinent whilst drawing blood during glucometer reading.

- DO NOT RECAP used needles.

- Do not remove used needles from disposable syringes by hand.
- Do not bend or break used needles.

Place disposable syringes, lancets, needles, and other sharp items *promptly* in appropriate puncture-resistant containers.

4 Reprocessing Single-Use Devices

In general, all single use devices should be used as such. However, in resource limited settings consumables meant for one-time use are commonly reused due to cost and supply chain limitations.

Departmental policy for disinfecting and reprocessing single-use-devices must always be strictly followed in order to prevent infection spreading between patients.

When reprocessing single-use devices, it is extremely important that the cleaning process is not delayed following completion of use. There should be a detailed standard of practice as well as oversight processes for ensuring timely and high-quality reprocessing. If equipment is not reprocessed promptly or adequately between patients, it poses a significant infection risk. Please refer to the **Reference Manual for Health Care Facilities with Limited Resources Infection Prevention and Control, Module 6³** for more detailed guidance on reprocessing of single-use devices.

Respiratory circuits, tubing and equipment are the most commonly reprocessed single-use devices. **Syringes, needles, and disposable gloves must never be reprocessed.**

Assessment Questions

- 1 What disinfectant does WHO recommend using for cleaning surfaces and the housing of equipment?

0.5% dilution of chlorine

- 2 What surfaces and types of equipment does diluted bleach corrode?

Metal/rubber and electronic equipment; 70% alcohol

What is an alternative low-level disinfectant that might be used on these surfaces?

70% alcohol

- 3 What is the first action to take before handling a baby and what is the last action you take after completing a task?

Wash hands; remove and dispose of gloves.

References

- 1 Water, sanitation, hygiene and health: a primer for health professionals. Geneva: World Health Organization; 2019 (WHO/CED/PHE/WSH/19.149). Licence: CC BY-NC-SA 3.0 IGO.
- 2 World Health Organization, Regional Office for the Western Pacific, World Health Organization & Regional Office for South-East Asia. *Practical guidelines for infection control in health care facilities*. (World Health Organization, Regional Office for Western Pacific; World Health Organization, Regional Office for South-East Asia, 2004).
- 3 Sharma, G. Infection Prevention and Control at Neonatal Intensive Care Units. 134.
- 4 Curless MS, Ruparelia CS, Thompson E, and Trexler PA, eds. 2018. Infection Prevention and Control: Reference Manual for Health Care Facilities with Limited Resources. Jhpiego: Baltimore, MD.