



# NEST-ED

## Clinical Modules

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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**

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Newborn Essential Solutions and Technologies-Education  
Clinical Modules: Glucometer

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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  
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## ABBREVIATIONS

<b>ABC</b>	Airway, Breathing, Circulation
<b>bCPAP</b>	Bubble continuous positive airway pressure
<b>dL</b>	Decilitre
<b>FiO<sub>2</sub></b>	Increased Fractional Concentration of Oxygen
<b>Fr</b>	French size
<b>HAI</b>	Hospital acquired infections
<b>HCWs</b>	Healthcare workers
<b>HFNC</b>	High flow nasal cannula
<b>IV</b>	Intravenous
<b>KMC</b>	Kangaroo mother care
<b>LBW</b>	Low birth weight
<b>LCD</b>	Liquid crystal display
<b>LED</b>	Light emitting diode
<b>mm Hg</b>	Millimeters of mercury
<b>NEST360°</b>	Newborn Essential Solutions and Technologies
<b>NEST-ED</b>	Newborn Essential Solutions and Technologies-Education
<b>NGT</b>	Nasogastric tube
<b>nm</b>	Nanometer
<b>O<sub>2</sub></b>	Oxygen
<b>OGT</b>	Orogastric tube
<b>ppm</b>	Parts per million
<b>ROP</b>	Retinopathy of Prematurity
<b>SpO<sub>2</sub></b>	Peripheral blood oxygen saturation
<b>UPS</b>	Uninterruptible power supply
<b>WASH</b>	Water, sanitation and hygiene
<b>WHO</b>	World Health Organization
<b>wks</b>	Weeks

## NOMENCLATURE

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

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# Introduction

This NEST-ED Clinical Module has been prepared to help healthcare staff & students understand when & how to use glucometers 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.

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# Point-of-Care Diagnostics

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## Glucometer

# 1 Clinical Problem

**Assessment of blood glucose with a glucometer should be conducted as part of routine assessment for all infants on admission.**

Glucometers should also be used during continuing management for all sick or at-risk patients. Hypoglycaemia may present as:<sup>1</sup>

- Jitteriness
- Irritability
- Hypotonia
- Lethargy
- Reduced level of consciousness
- Failure to feed or poor feeding
- Seizures
- Hypothermia
- Apnoea or irregular breathing

Hypoglycaemia may also be asymptomatic or the signs may be very non-specific and identified incidentally as part of routine blood glucose testing.<sup>1</sup> It is important to identify hypoglycaemia as it may lead to permanent brain damage. Prematurity, intrauterine growth retardation, birth asphyxia, babies born to diabetic mothers, and sick babies are all especially prone to develop hypoglycaemia.

# 2 Assessment

**Hypoglycaemia occurs in 10% of healthy neonates but can also directly contribute to both morbidity and mortality.<sup>2,3</sup> It is the most common medical emergency to occur in neonatal patients.**

Glucometers **(2.1)** provide a rapid measurement of approximate whole blood glucose level<sup>1</sup> to direct treatment for patients with mild to severe hypoglycaemia. Where available, point of care tests should be confirmed by laboratory analysis when hypoglycaemia is persistent, recurrent, or there is concern about accuracy of the point of care device.

Glucometers use test strips **(2.2)** with a glucose oxidase electrode. These strips generate a current proportional to the glucose in the blood that reacts with the glucose oxidase, which is then measured and analysed to determine an estimated blood glucose level.



2.1 Glucometers.



2.2 Glucometer test strips.

There are multiple types of glucometers, including portable and benchtop. Glucose strips that change colour according to a visual scale are also available for measuring glucose levels. **These are not recommended due to their higher inaccuracy and subjective nature of measurement.** Not all glucometers are accurately able to measure hypoglycaemia in neonatal patients;<sup>4,5</sup> all devices in use should be thoroughly validated for use both in neonatal patients and as an assessment of hypoglycaemia.

Glucose levels in all neonatal patients should not fall below **2.5 mmol/L** (45 mg/dL).

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## 3 Management

Management of a glucometer covers how to use the device in a variety of settings, including set up for a patient, patient preparation & conducting & concluding the assessment.

### SETTING UP FOR A PATIENT

- 1 Collect: **(3.1)**
  - Glucometer
  - Glucometer strips
  - Control solutions
- 2 Turn on the glucometer. This may be completed by pressing the power button of the glucometer or inserting a glucometer strip into the glucometer strip port.



3.1 Collect glucometer, test strip & control solutions.

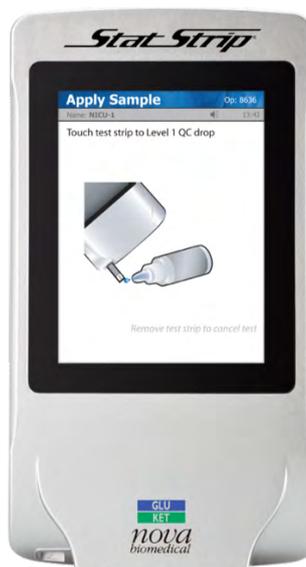


3.2 Insert strip.

- 3 Fully insert a test strip into the meter. **(3.2)** The strip should click into place.
- 4 A **Quality Control** test should be conducted daily. If this has not been completed, perform a test using the control solutions provided with the glucometer **(3.3)**, or a solution of known glucose content. The solution should be placed on the strip as with a normal sample. **(3.4)** The results should appear within seconds as a **Pass**. **(3.5)**



3.3 Collect control solutions.



3.4 Allow the strip to absorb a drop of the control solution.



3.5 The control solution should test as a **Pass**.

## PREPARING A PATIENT

- 1 Assess patient for clinical conditions associated with hypoglycaemia.
- 2 Always explain the purpose, risks and benefits of a procedure to guardians BEFORE performing the procedure.
- 3 Follow handwashing protocol and put on gloves.

- 4 Collect:
  - Gloves
  - 70% Alcohol
  - Cotton swab
- 5 Clean the skin on the outer edge of the patient's heel using cotton wool soaked in alcohol. **(3.6)** Allow the alcohol to dry before testing. **Blood glucose samples should never be taken from the finger of a neonate. Avoid areas of skin which are poorly perfused, oedematous, inflamed or infected.**



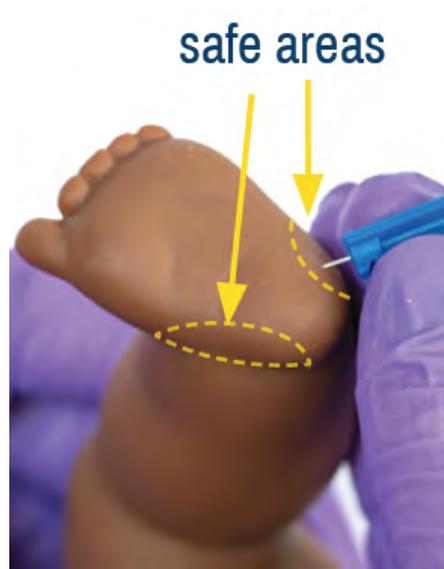
**3.6** Clean outer edge of the patient's heel using cotton/gauze soaked in alcohol.

## ASSESSING A PATIENT

- 1 Collect: **(3.7)**
  - New lancet
  - Glucometer
  - Glucometer strip
  - Cotton swabs
  - Alcohol (swabs/solution)
  - Gloves
  - A small tray to carry the items above
- 2 Follow handwashing procedures & put on gloves.
- 3 Insert glucometer strip into glucometer and ensure it is turned on.
- 4 Using the lancet, prick the disinfected outer edge of the heel. **(3.8)** A blood drop should form. If this does not occur, massage the heel to generate the blood drop. The patient may cry during blood collection as use of the lancet can be painful.
- 5 Wipe the first drop from the patient's skin and generate an additional blood drop. Collect the second blood drop on the tip of the glucometer strip. **(3.9)** The glucometer should automatically absorb the blood drop.



3.7 Collect assessment materials.

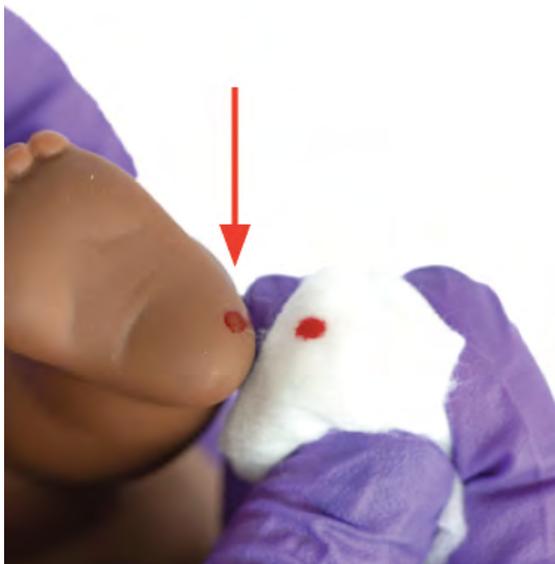


3.8 Prick disinfected outer edge of heel using lancet.



3.9 Collect blood drop on glucometer strip.

- 6 Using a dry cotton swab, apply pressure to the heel to stop the bleeding. (3.10)
- 7 Blood glucose level will be displayed as a number on the glucometer screen. (3.11) Read and record the glucose levels. If the measurement is not in accord with the clinical condition of the patient, repeat the test.



3.10 Apply pressure to stop bleeding.



3.11 Read & record glucose levels.

- 8 Compare glucose levels to normal standards.<sup>6</sup>
  - If levels fall **below 2.5 mmol/L** (45mg/dL) but the baby is **alert**, can breastfeed, be fed by cup and spoon or has a nasogastric tube, give extra feed and recheck in 2 hours.
  - If levels fall **below 2.5 mmol/L** (45mg/dL) but the baby is **unable to feed**, immediately administer 2 mL/kilogram 10% dextrose IV and then start an infusion of 10% dextrose.
  - If levels fall **below 1.2 mmol/L** (21.6mg/dL) in **any baby**, immediately administer 2 mL/kilogram 10% dextrose IV and then start an infusion of 10% dextrose.

Whenever hypoglycaemia is found and treated, the blood glucose should be rechecked 30 minutes after intervening.



### ALERT 3.1: Variance in international standards for hypoglycaemia management

American Academy of Pediatrics, Pediatric Endocrine Society and WHO are all in agreement that glucose levels below 2.5mmol/L (45mg/dL) signify hypoglycaemia in newborns. However, they differ on the specific actions that should be taken and how aggressively to manage glucose levels below 45mg/dL, (2.5 mmol/L). For a full discussion of management of hypoglycaemia in newborns, these documents should be referenced and local practices put into place.<sup>7-9</sup>

## CONCLUDING ASSESSMENT

Remove the glucose strip from the glucometer and dispose of strip in hazardous waste container. Dispose of the used lancet in sharps container. Remove gloves, dispose in hazardous waste container, and wash hands.

# 4 Infection Prevention

**Routine and adequate cleaning of medical devices is critical to prevent hospital-acquired infections in newborn care units. If devices and equipment are not disinfected or reprocessed promptly or adequately between patients, they may pose a significant infection risk.**

## GENERAL INFECTION PREVENTION

- 1 Clean hands with soap and water or alcohol before and after assessing a patient using a glucometer or handling any materials that will be used on a patient (e.g., a lancet). **Gloves should be worn throughout the process of taking a blood glucose measurement and disposed of immediately after concluding the measurement.**
- 2 Always thoroughly clean the patient's skin before taking a measurement using a glucometer. Inadequate cleaning of the skin may result in an infection. Taking a sample from a site with a skin infection also poses the risk of infection dissemination.
- 3 Ensure that all patient-related consumables are new before use. Materials used in blood glucose measurements **should never be reused.**
- 4 All patient-related consumables should be stored in a clean, dry location. Glucometer measurement strips should be stored in an airtight container and according to hospital policy.
- 5 Follow universal precautions of handling sharps.



## ALERT 4.1 Equipment Disinfection

Disinfection of equipment should always comply with manufacturer guidelines. General guidance on environmental cleaning and disinfection of equipment was taken from the [Infection Prevention and Control: Reference Manual for Health Care Facilities with Limited Resources, Jhpiego, Module 6<sup>8</sup>](#) which lists isopropyl alcohol (70-90%), sodium hypochlorite (0.05% or >100ppm available chlorine) quaternary ammonium, and Iodophor germicidal detergent as appropriate for low level disinfection. Phenolic germicidal detergent is also listed in this category but should not be used in neonatal wards since affordable, effective alternatives are available; and, there are concerns it may cause hyperbilirubinemia and/or neurotoxicity in neonates.<sup>9</sup>

When utilizing re-processed devices meant for single-use (like temperature probes), careful attention must always be paid to assure that devices are continuing to function properly.

## DISINFECTION AFTER USE

- 1 Remove the glucose strip from the glucometer and dispose of strip in hazardous waste container. Dispose of used lancet in sharps container. Remove gloves, dispose in hazardous waste container, and wash hands.
- 2 Wipe down the glucometer with 70% alcohol. **(4.1)** Be careful not to submerge or drip alcohol onto the glucometer, particularly in its glucometer strip reading slot.



4.1 Wipe down the glucometer with 70% alcohol.

# 5 Complications

Introduction of equipment in newborn care units poses clinical and device complications for patients. Awareness of potential complications is critical to maximise patient safety.

## CLINICAL COMPLICATIONS

- **Bruising:** inappropriate or repeated attempts to collect blood for glucose testing may result in bruising to the heel.
- **Bleeding:** if pressure is not applied post blood collection bleeding may persist for a short period of time. Continued bleeding may indicate an underlying bleeding disorder.
- **Artery, nerve or bone damage:** do not use the back or the inner part of the heel for blood collection. This may cause artery, nerve, or bone damage.
- **Pain:** the lancet prick can cause pain, employ appropriate soothing measures.
- **Infection:** rarely infection may occur at the site if infection precautions are not adequate.

## DEVICE COMPLICATIONS

- **Falsely high readings:** dextrose gel or substances on the skin can affect readings. If you record a very high reading in a patient that is otherwise showing symptoms of hypoglycaemia, consider recleaning the patient's skin and retaking the measurement.
- **Expired glucose strips:** outdated or improperly stored glucose strips can produce inaccurate readings. Make sure the lid is kept tightly on the strip container as humidity damages the strips. When possible, unexpired glucometer strips should not be used.

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# 6 Care & Maintenance

**Users are responsible for basic first-line care and maintenance to ensure equipment lasts to their potential lifetime.**

## POWER SOURCE

A glucometer is powered by replaceable or rechargeable **(6.1)** batteries. If using a rechargeable device, the users should regularly charge the pulse oximeter when not in use to ensure power in the event of a power outage.

## WARD LOCATION

The glucometer and associated glucometer testing strips should be stored in a clean, dry and secure area. As glucometers are fairly small, care should be taken to ensure that they remain on the ward and accessible for use when required. If the glucometer has a docking or charging station, it should be kept on the dock or charging station when not in use. **(6.2)**



6.1 Low battery warning.



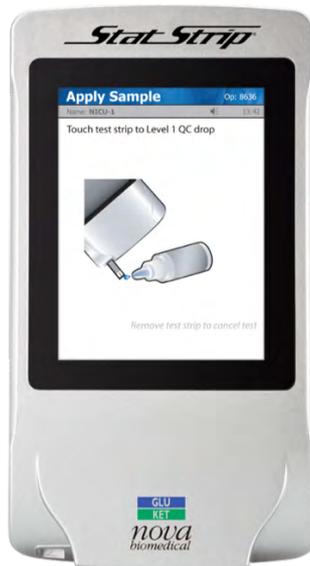
6.2 Glucometer on its charging port.

## USER PREVENTIVE MAINTENANCE

Glucometers require little preventive maintenance beyond recharging or replacing batteries. A **Quality Control** test using the control solutions provided with the glucometer (6.3), or a solution of known glucose content should be conducted monthly or when changing glucometer strip containers to ensure consistent results. The solution should be placed on the strip as with a normal sample. (6.4) The results should appear within seconds as a **Pass**. (6.5)



6.3 Collect control solutions.



6.4 Allow the strip to absorb a drop of the control solution.



6.5 The control solution should test as a **Pass**.

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# 7 Troubleshooting & Repair

Although users are not responsible for repairing their devices, there are steps that may be taken to troubleshoot first-line errors that may occur before contacting maintenance or engineering support.

## 1 The glucometer is not turning on:

- Some models of glucometer require a strip to be inserted and will automatically turn on once this is completed. Try inserting a glucometer strip.
- If the glucometer still does not turn on, try charging or replacing the batteries. If the glucometer still does not turn on, contact your maintenance department.

## 2 The glucometer is providing results consistently incompatible with patient conditions:

- Check the expiration date of the glucometer strips. If the strips are expired, try using non-expired strips.
- If the results are still inconsistent, complete a quality control test as described in **Glucometer: Care & Maintenance | Preventive Maintenance**. If the results are still inconsistent, contact your maintenance department.

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# Assessment Questions

- 1 How often should quality control tests be performed on glucometers?

Daily, monthly & when a new container of glucometer strips is opened

- 2 On the image of the foot below, mark the area of the foot that is most safely used to collect blood for a glucometer reading.



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