Syringe Pump

NEST-ED Clinical Module

December 2022

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.
# Table of Contents

<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Abbreviations &amp; Nomenclature</td>
<td>3</td>
</tr>
<tr>
<td>Introduction</td>
<td>4</td>
</tr>
<tr>
<td>Syringe Pump</td>
<td>6</td>
</tr>
<tr>
<td>1 Clinical Problem</td>
<td>6</td>
</tr>
<tr>
<td>2 Assessment</td>
<td>6</td>
</tr>
<tr>
<td>3 Management</td>
<td>7</td>
</tr>
<tr>
<td>4 Infection Prevention</td>
<td>14</td>
</tr>
<tr>
<td>5 Complications</td>
<td>15</td>
</tr>
<tr>
<td>6 Care &amp; Maintenance</td>
<td>16</td>
</tr>
<tr>
<td>7 Troubleshooting &amp; Repair</td>
<td>16</td>
</tr>
<tr>
<td>Assessment Questions</td>
<td>17</td>
</tr>
<tr>
<td>Appendix A</td>
<td>18</td>
</tr>
<tr>
<td>References</td>
<td>21</td>
</tr>
<tr>
<td>Disclaimer</td>
<td>22</td>
</tr>
<tr>
<td>Acknowledgments</td>
<td>23</td>
</tr>
<tr>
<td>Materials Summary</td>
<td>23</td>
</tr>
</tbody>
</table>
ABBREVIATIONS

- cm: Centimeter
- D10%: 10% dextrose
- Hr/s: Hour/s
- IV: Intravenous
- Kg: Kilogrammes
- LBW: Low birth weight
- LCD: Liquid crystal display
- mls: Milliliters
- mls/hr: Milliliters per hour
- mls/kg: Milliliters per kilogramme
- NEST360: Newborn Essential Solutions and Technologies
- NEST-ED: Newborn Essential Solutions and Technologies-Education
- NPO: Nil per os
- VLBW: Very low birth weight
- VTBI: Volume to be infused

NOMENCLATURE

- Syringe pump: Syringe driver, infusion pump
- Cot: Bassinet, infant crib
- Hospital acquired infection: Iatrogenic infection, nosocomial infection
- Trophic feeds: Minimal enteral feeds, priming feeds or non-nutritive feeds
Introduction

This NEST-ED Clinical Module has been prepared to help healthcare staff and students understand when and how to use a syringe pump 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. Hospitals, clinical departments and individuals may use them to update their knowledge and to better facilitate the effective and safe use of newborn care equipment.

Whilst reading this series on a digital device, download and open the document in Adobe Acrobat. On the toolbar, click View, Navigation Panes and then click Bookmarks. Use the Bookmarks pane to navigate between sections of the document.

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 and 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 warmer 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 an infant 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.
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.

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.

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.

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 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.

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 a brief explanation of reasoning for the current module content is provided.

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

Small or sick newborns may require intravenous fluids in the first one to two weeks of life until they achieve full feeds.

Common reasons to require intravenous (IV) fluids during the neonatal period include prematurity and severe illness such as respiratory distress syndrome, asphyxia, sepsis and necrotising enterocolitis. When neonates require IV fluids, they must be administered in small, precise amounts in order not to cause harm.

This module focuses on the use of syringe pumps as a life-saving tool for routine care of small and sick newborns who require IV fluids during the gradual introduction of enteral feeds. (Alert 1.1) While there are numerous uses for the syringe pumps in newborn care, including administration of medication or continuous enteral feeding, these will not be covered by this module.

2 Assessment

Infants who are not being fed regularly are at high risk of developing hypoglycaemia and dehydration. They require IV fluids in small volumes and at precise infusion rates that are difficult to achieve safely using burettes and drip counting. Syringe pumps can be used for the controlled infusion of small volumes of IV fluids until infants are able to achieve full enteral feeds. (Appendix A)

Syringe pumps vary widely in complexity, functionality and ability to accommodate specific syringes. A syringe pump uses an internal motor to push a syringe plunger at a specified rate to ensure consistent delivery of a predetermined volume of fluid. Additionally, pumps may have the ability to deliver more than one fluid or medication at a time. Some syringe pumps can also be linked with electronic medical record systems.

Patients should receive intravenous fluid, calculated as volume per hour, based on their weight, age and intake of oral feeds. The appropriate rate of delivery and fluid requirements is important. Due to their small weights and immature kidneys, newborns should never be given fluid too quickly or in too large volumes.

This clinical module will provide an overview of the use of a syringe pump that accommodates non-brand specific syringes to deliver IV fluid.
Alert 2.1 Fluid Selection

Administering IV fluids to small and sick newborns has significant potential for error and infection. This is especially relevant where IV fluids are mixed in the ward prior to delivery. Also, measuring electrolytes may be infrequent, difficult to obtain or unreliable. Many small infants who are advancing feeds as expected and are likely to achieve full feeds between 7-10 days of life, will do well with administration of only 10% dextrose without additional electrolytes.

3 Management

Management of a syringe pump includes how to set up and use the device, prepare the patient, deliver the IV fluid and conclude the treatment.

PREPARING A PATIENT

Ensure the newborn has a well-functioning IV cannula in place.

SETTING UP DEVICE FOR A PATIENT

1 Collect:
   - Syringe pump and power cable (Figures 3.1a, 3.1b)
   - 10-60ml syringe filled with prescribed IV fluid
   - IV extension tubing
   - 70% alcohol
   - Cotton wool or gauze
   - Gloves

Figure 3.1a Syringe pump overview.
2 Observe hand hygiene and put on gloves as appropriate.

3 Position the syringe pump appropriately: (Figure 3.3)
   - **NEVER** place a syringe pump in a cot.
   - The syringe pump should be **no more than 100 cm above or below the level of a newborn’s heart** as this will enable the device to more accurately detect pressure and alarm appropriately during the IV infusion.
   - **There should be at least 5 cm** between the syringe pump and other equipment to ensure air can circulate around the device to prevent it from overheating.
   - **ALWAYS** ensure that the syringe pump is on a flat, stable surface where it is not in danger of falling on the infant or being knocked to the floor.
   - **Alternatively**, a syringe pump can be mounted to a drip stand. (Figure 3.4)

4 Connect the power cable to the syringe pump. (Figure 3.2) Plug into socket and switch on.
5 Prepare and prime the syringe and extension tubing manually.
   - Fill a 10 – 60 ml syringe with the prescribed IV fluid.
   - Hold the syringe upright and remove air bubbles by pushing the plunger until all air is removed.
   - Attach the prepared syringe to the sterile un-primed extension tubing. (Figure 3.5a)
   - Push the syringe plunger to fill the extension tubing until a few drops of fluid fall from the end. Ensure tubing is clear of any air bubbles. (Figure 3.5b)
   - Keep the patient end of the extension tubing sterile until attaching to the infant’s IV cannula.

6 Turn the syringe pump on. (Figure 3.6)

7 Place the prepared syringe with extension tubing into the syringe pump. (Figure 3.7)

8 Continue to ensure that the patient end of the extension tubing remains sterile.

9 If required by the device:
   - Select syringe brand and size. (Figure 3.8a)
- Set the infusion rate. *(Figure 3.8b)*
- Enter the total volume to be infused (VTBI). *(Figure 3.8c)*

**Figure 3.8a** Select syringe brand and size.

**Figure 3.8b** Set infusion rate as prescribed.

**Figure 3.8c** Enter VTBI (volume to be infused).

---

**STARTING A PATIENT**

1. **Collect:**
   - Gloves
   - 70% alcohol
   - Cotton wool or gauze
   - Small tray to carry items

2. **Wash hands and put on gloves.**

3. **Recheck** the extension tubing between the device and the patient again to ensure that it is free of air bubbles. There should be **NO AIR ANYWHERE IN THE SYRINGE OR EXTENSION TUBING.** If there are bubbles, then **disconnect** and either press the bolus button or manually prime the extension tubing and syringe again prior to reconnecting to patient.

4. **Disinfect** the hub of the patient’s cannula as well as the extension tubing using cotton wool/gauze soaked in 70% alcohol and allow to dry.

5. **Connect** the extension tubing to the cannula taking sterile precautions. *(Figure 3.9)*
6 Confirm the settings and press the start button to initiate infusion. *(Figure 3.10)*

7 Inspect IV site to ensure that there is no swelling or redness.

8 Document the time, rate and type of fluid commenced.

---

**CARING FOR A PATIENT**

Guardians are important to involve in the monitoring when using the syringe pump and should be taught what to look for and when to raise concerns. As a minimum the patient should be assessed at the time an infusion is started, at 30 minutes and then no less frequently than 4-hourly for:

1 Redness, swelling at IV site or cannula displacement. If any of these are present or there is an occlusion alarm:
- Stop the syringe pump.
- Wash hands and put on gloves.
- Disconnect the extension tubing from the cannula.
- If the patient’s IV site is red, swollen or the cannula is displaced, then re-site the cannula.
- If the occlusion alarm is sounding, flush the patient’s IV cannula in a sterile manner to ensure patency.
  a) If the cannula CANNOT be flushed easily, re-site.
  b) If the cannula CAN be flushed easily, check the extension tubing for any kinks and ensure the extension tube clamp (if present) is open.

2 Document vital signs, including respiratory rate, heart rate, oxygen saturation and temperature.
3 Record the input/output on a fluid chart.
4 When the syringe is empty and if fluids continue to be required, repeat the process for starting a patient on an infusion with a new syringe and extension tubing.
5 If the infusion is required for longer than 24 hours replace the syringe and extension tubing every 24 hours.

**REMOVING A PATIENT**

1 If the delivery of fluids is complete and the patient does not require more fluid, press stop on the syringe pump. *(Figure 3.11a)*
2 Turn the device off. *(Figure 3.11b)*

![Figure 3.11a Stop infusion.](image)

![Figure 3.11b Turn pump off.](image)

3 Wash hands and put on gloves.
4 For the patient, disconnect the extension tubing from the cannula and close the cannula with a cap (Luer lock plug).
5 Open the syringe pump clamp and slider clamp if required, remove the syringe and extension tubing and discard in clinical waste container. *(Figure 3.12)*
6  Wipe down the syringe pump housing and screen with 70% alcohol.

Alert 3.1 Single-use Items

Syringes, extension tubings, IV cannulas and needles must NEVER be reprocessed for re-use and ALWAYS be disposed of in appropriate waste containers at the conclusion of treatment.
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 promptly or adequately between patients, they may pose a significant infection risk.

**GENERAL INFECTION PREVENTION**

1. Clean hands with soap and water or 70% alcohol and put on gloves before accessing or placing an IV line.
2. Ensure that all patient-related consumables including syringe, extension tubing and IV cannula are new. Materials used for intravenous delivery that have come in contact with body fluids must never be reused.
3. All patient-related consumables should be stored in a clean, dry location.

**DISINFECTION AFTER USE**

1. Turn off and unplug the syringe pump.
2. Dispose of the tubing and syringe in clinical waste container.
3. If there has been any spillage or obvious soiling, first clean with mild soap and water taking care not to allow water to enter the device. Disinfect the device using cotton wool or gauze soaked in 70% alcohol after every use. (Figure 4.1)

![Figure 4.1 Disinfect the turned-off device with 70% alcohol.](image-url)
5 Complications

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

**CLINICAL COMPLICATIONS**

- **Infection**: inadequate cleaning of the skin prior to cannula insertion, use of a long-term indwelling cannula and contamination of the extension tubing, syringe or IV fluids during preparation are all risks for infection.

- **Extravasation injury**: if the cannula stops working or becomes displaced but fluid administration continues, there is risk of injury to the surrounding tissues. It is important to frequently reassess the cannula site and respond to syringe pump alarms to prevent this.

- **Fluid overload**: delivery of intravenous fluid at too fast a rate or in too large a volume may result in fluid overload leading to oedema, heart failure, respiratory distress and/or death.

- **Dehydration and hypoglycaemia**: if the cannula is displaced or stops working, the extension tubing is kinked or the syringe pump malfunctions, delivery of fluid is obstructed potentially resulting in dehydration or hypoglycaemia.

- **Air emboli**: if there is air in the syringe or the extension tubing an air embolus may occur. Air emboli can cause respiratory difficulties, heart failure or death.

**DEVICE COMPLICATIONS**

- **Errors related to syringe type**: Use of the incorrect brand of syringe in a pump that uses a specific syringe brand may cause infusion of an inaccurate volume of fluid.

- **Errors related to syringe placement**: If the syringe is not placed or loaded correctly in the pump, it will not work.

- **Errors related to tubing**: If extension tubing is kinked, the fluid will no longer flow and an alarm should sound.
6 Care & Maintenance

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

**POWER SOURCE**

Most syringe pumps are mains-powered with a rechargeable battery. A syringe pump should be taken off its charger only as necessary to ensure that it is charged and ready for use in the event of a power blackout. Whenever a prolonged blackout occurs, which could exhaust the battery life, care should be taken to continue administration of fluid by nasogastric, cup or breast, as clinically appropriate.

**WARD LOCATION**

Syringe pumps may be stored securely on a shelf or mounted a drip stand for easy access. When NOT in use store in a clean, dry location.

**USER PREVENTIVE MAINTENANCE**

The syringe pump should be turned on every week if not in use. Visually inspect the syringe pump for any missing parts or alarms during this test.

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. **If the syringe pump is not turning on when plugged into main power:**
   - Check that the power cable is secured to the back of the syringe pump and that power at the socket is on.
   - If the syringe pump still does not turn on, contact your maintenance department.

2. **If the syringe pump is not running on battery power:**
   - Check that the battery has been charged without interruption for at least 10 hours.
   - If the battery is charged but the device will still not run on battery power, contact your maintenance department.
   - If the length of the battery’s lifetime is obviously shorter than that claimed in the specifications, contact your maintenance department.

3. **If the flow volume is inaccurate or the device is incorrectly identifying syringes:**
   - Contact your maintenance department.
Assessment Questions

1. What preventive maintenance steps should be taken for the syringe pump?
   Answer: When not in regular use turn on the syringe pump every week and inspect for any missing parts or physical damage.

2. When fluids are given too fast or in too large a volume, what is the potential clinical complication?
   Answer: Fluid overload: oedema, heart failure, respiratory distress and/or death.

3. What should you do if the occlusion alarm is sounding?
   Answer: Flush the patient’s IV cannula in a sterile manner to ensure patency.
   • If the cannula CANNOT be flushed easily, re-site.
   • If the cannula CAN be flushed easily, check the extension tubing for any kinks and ensure the extension tube clamp (if present) is open.

4. What is the MOST important step in prevention of extravasation injury?
   Answer: Frequent assessment of cannula site.

5. Label the syringe pump image below using the numbers or letters beside these titles:
   • Buttons: a) start infusion (1), b) stop infusion (2), c) power (3), d) silence alarm (4)
   • Primed syringe and extension tubing (A)
   • Slider (B)
   • Slider clamps(C)
   • Syringe clamp (D)
   • Syringe flange slot (E)
Appendix A

Fluid Requirements

Small or sick newborns may require gradual introduction of feeds over the first one to two weeks of life.

Stable, preterm newborns benefit from small, frequent feeds that facilitate more rapid progression to full enteral feeding, weight gain, feeding tolerance, less severe jaundice and shorter hospitalisation. For newborns weighing more than 1kg start trophic feeds with breast milk on the first day of life at 5-25 ml/kg/day. Increase the feeds by 20-30 ml/kg/day as tolerated, until the infant achieves full feeds.

Establishing an adequate supply of breastmilk is a critical, life-saving but difficult task for mothers of small or sick infants. It is crucial that the staff of newborn units support mothers in this task. Even very low birthweight infants without complications are able to achieve full feeds in about one week with adequate support.

Every neonatal unit should have an explicit plan to support lactation, introduce breastmilk and transition from IV fluids (if being used) to fully established enteral feeds for all newborns. This will help to reduce morbidity, mortality and length of hospital stay. Local protocols are important as a consistent approach is critical for successfully establishing full feeds in the first 1-2 weeks of life. An example is given in the tables below.

Notes on calculating IV fluids and feeds

- Tables below are designed to minimise the need for calculations in order to avoid errors.
- Most protocols recommend a 20-30 ml/kg/day increase in feeds and the example tables below stay within this range.
- Recent evidence shows that 3 hourly feeds are acceptable, even in small newborns.
- For infants with hypoxic ischaemic encephalopathy, surgical conditions or other special needs refer to local protocols.

<table>
<thead>
<tr>
<th>Birth weight 1–1.5 kg (VLBW), estimated as 1.25 kg for calculation</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Day of Life</strong></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>0</td>
</tr>
<tr>
<td>1</td>
</tr>
<tr>
<td>2</td>
</tr>
<tr>
<td>3**</td>
</tr>
<tr>
<td>4</td>
</tr>
<tr>
<td>5</td>
</tr>
<tr>
<td>6</td>
</tr>
<tr>
<td>7</td>
</tr>
<tr>
<td>8</td>
</tr>
</tbody>
</table>

*All babies in this weight band will probably require cup or gastric tube feeding with expressed breastmilk until able to breastfeed and gain weight.

**As long as the patient is tolerating and increasing feeds, remain on D10% alone. If NPO consider changing fluids to D10% with electrolytes on day 3 of life.
### Birth weight 1.5–2 kg (LBW), estimated as 1.75 kg for calculation

<table>
<thead>
<tr>
<th>Day of Life</th>
<th>Total daily fluid requirement: IV+PO</th>
<th>IV fluid – D10%</th>
<th>Enteral*</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>ml/kg/day ml/kg/24hrs ml/hr</td>
<td>ml/kg/24hrs</td>
<td>ml/3hrs</td>
</tr>
<tr>
<td>0</td>
<td>60 60 4</td>
<td>0 - trophic</td>
<td>0 - trophic</td>
</tr>
<tr>
<td>1</td>
<td>80 50 4</td>
<td>30 7</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>100 40 3</td>
<td>60 13</td>
<td></td>
</tr>
<tr>
<td>3**</td>
<td>120 30 2</td>
<td>90 20</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>140 20 1</td>
<td>120 26</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>150 0 0</td>
<td>150 33</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>170 0 0</td>
<td>170 37</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>180 0 0</td>
<td>180 39</td>
<td></td>
</tr>
</tbody>
</table>

*All babies in this weight band will probably require cup or gastric tube feeding with expressed breastmilk until able to breastfeed and gain weight.

**As long as the patient is tolerating and increasing feeds, remain on D10% alone. If NPO consider changing fluids to D10% with electrolytes on day 3 of life.

### Birth weight 2–2.5 kg and unable to breastfeed, estimated as 2.25 kg for calculation

<table>
<thead>
<tr>
<th>Day of Life</th>
<th>Total daily fluid requirement: IV+PO</th>
<th>IV fluid – D10%</th>
<th>Enteral*</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>ml/kg/day ml/kg/24hrs ml/hr</td>
<td>ml/kg/24hrs</td>
<td>ml/3hrs</td>
</tr>
<tr>
<td>0</td>
<td>60 60 6</td>
<td>0 - trophic</td>
<td>0 - trophic</td>
</tr>
<tr>
<td>1</td>
<td>80 50 5</td>
<td>30 8</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>100 40 4</td>
<td>60 17</td>
<td></td>
</tr>
<tr>
<td>3**</td>
<td>120 30 3</td>
<td>90 25</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>140 20 2</td>
<td>120 34</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>150 0 0</td>
<td>150 42</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>170 0 0</td>
<td>170 48</td>
<td></td>
</tr>
</tbody>
</table>

*Change to breastfeeding as soon as baby is able.

**As long as the patient is tolerating and increasing feeds, remain on D10% alone. If NPO consider changing fluids to D10% with electrolytes on day 3 of life.
Birth weight 2.5–3 kg and unable to breastfeed, estimated as 2.75 kg for calculation

<table>
<thead>
<tr>
<th>Day of Life</th>
<th>Total daily fluid requirement: IV+PO</th>
<th>IV fluid – D10%</th>
<th>Enteral*</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>ml/kg/day</td>
<td>ml/kg/24hrs</td>
<td>ml/hr</td>
</tr>
<tr>
<td>0</td>
<td>60</td>
<td>60</td>
<td>7</td>
</tr>
<tr>
<td>1</td>
<td>90</td>
<td>50</td>
<td>6</td>
</tr>
<tr>
<td>2</td>
<td>120</td>
<td>40</td>
<td>5</td>
</tr>
<tr>
<td>3**</td>
<td>150</td>
<td>30</td>
<td>3</td>
</tr>
<tr>
<td>4</td>
<td>150</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

*Change to breastfeeding as soon as baby is able.
**As long as the patient is tolerating and increasing feeds, remain on D10% alone. If NPO consider changing fluids to D10% with electrolytes on day 3 of life.

Alert A.1 Transition from IV fluids to enteral feeds

To prepare these tables, the following protocols were looked at:
- WHO hospital care for children guidelines
- Essential newborn care guidelines adopted by UNICEF
- Care of the young infant and newborn (COIN - Malawi)
- Comprehensive newborn care protocols (Kenya)
- Neonatal care guidelines (Rwanda Paediatric Association)

Some protocols distinguish between total daily fluid requirements of newborns below and above 1.5 kg but otherwise agree. Most agree the maximum daily fluid requirement to be about 180 ml/kg/day but up to 200 ml/kg/day may be required. There is general consensus that if an infant is still NPO on day 3 of life, electrolytes should be added to the IV fluids.
References


This series reflects the work of the NEST360 team through a joint effort with partner organisations. Some rights reserved. This work is available under the Creative Commons Attribution-NonCommercial-ShareAlike 4.0 International license (CC BY-NC-SA 4.0; https://creativecommons.org/licenses/by-nc-sa/4.0/).

Under the terms of this license you may copy, redistribute and adapt the work for non-commercial purposes, provided the work is appropriately cited as indicated below. In any use of this work there should be no suggestion that NEST360 endorses any specific organisation, products or services. The unauthorised use of the NEST360 name or logos is not permitted. If you adapt the work you must license it under the same or equivalent Creative Commons license. If you create a translation of this work you should add the following disclaimer along with the suggested citation: "This translation was not created by Newborn Essential Solutions and Technologies (NEST360). NEST360 is not responsible for the content or accuracy of this translation. The original English edition shall be the binding and authentic edition".


**Rights and licensing.** For queries on rights and licensing, see the full legal code for the Creative Commons Attribution-NonCommercial-ShareAlike 4.0 International Public License (https://creativecommons.org/licenses/by-nc-sa/4.0/legalcode).

Please contact nest360@rice.edu to obtain a version of the series that may be more easily adapted and integrated into other materials.

**Third-party materials.** If you wish to reuse material from this work that is attributed to a third party such as tables, figures or images, it is your responsibility to determine whether permission is needed for reuse and to obtain permission from the copyright holder. The risk of claims resulting from infringement of any third-party-owned component in the work rests solely with the user.

**General disclaimers.** All reasonable precautions have been taken by NEST360 to verify the information contained in this publication. The mention of specific companies or of certain manufacturers’ products does not imply that they are endorsed or recommended by NEST360 in preference to others of a similar nature that are not mentioned. The published material is being distributed without warranty of any kind, either expressed or implied. The responsibility for the interpretation and use of the material lies with the reader. In no event shall NEST360 or affiliated partner institutions be liable for damages arising from its use.

The authors have made every effort to check the accuracy of all information and instructions for use of any devices or equipment. As knowledge base continues to expand readers are advised to check current product information provided by the manufacturer of each device, instrument or piece of equipment to verify recommendations for use and/or operating instructions.

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.
ACKNOWLEDGMENTS

We are grateful to the NEST360 Education Writing Team of Sara Liaghati-Mobarhan, Josephine Langton, Elizabeth Molyneux, Jennifer Werdenberg, Edith Gicheha and Christina Samuel, who contributed to content, evidence review and coordination of publication of this document. We would also like to thank the NEST360 Education Group who contributed substantially to preparation of this content: Angela Okolo (Nigeria), Charles Osuagwu (Nigeria), Chinyere Ezeaka (Nigeria), Danica Kumara (USA), Dolphine Mochache (Kenya), Ekran Rashid (Kenya), Emmie Mbale (Malawi), George Banda (Malawi), Georgina Msemo (Tanzania), Grace Irimu (Kenya), Harold Chimphopo (Malawi), June Madete (Kenya), Karim Manji (Tanzania), Kondwani Kawaza (Malawi), Maria Oden (USA), Maureen Majamanda (Malawi), Mustapha Bello (Nigeria), Nahya Salim (Tanzania), Rebecca Richards-Kortum (USA), Robert Tillya (Tanzania), Vincent Ochieng (Kenya) and William Macharia (Kenya).

We thank the following people who reviewed the manual to provide expert opinion and guidance: Antke Züchner, Caroline Noxon, Carolyn Maclennan, Hans-Joerg Lang, Karim Manji, Mwanamvua Boga, Priscilla Wobil, Simon Nguranyang Phemoi, Simon Pius and Tim Baker.

We also thank Esalee Andrade-Guerrero, Thomas LaVergne, and Sara Desai for preparing the design, illustrations, and photography in this document.

NEST360 is made possible by generous commitments from the John D. and Catherine T. MacArthur Foundation, the Bill & Melinda Gates Foundation, The ELMA Foundation, the Children’s Investment Fund Foundation, The Lemelson Foundation, the Ting Tsung and Wei Fong Chao Foundation, and individual donors to NEST360.

MATERIALS SUMMARY

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 www.nest360.org/resources