Materials for the paediatric resuscitation trolley or backpack: Expert recommendations

Jesús López-Herce Cid,a∗, Antonio Rodríguez Núñezb, Ángel Carrillo Álvarezc, Gonzalo Zeballos Sarratoa, Cecilia Martínez Fernández-Llamazaresd, Custodio Calvo Maciase, Grupo Español de Reanimación Cardiopulmonar Pediátrica y Neonatal

Abstract Cardio-respiratory arrest (CPA) is infrequent in children, but it can occur in any place and at any time. This fact means that every health care facility must always have the staff and
Introduction

Cardiopulmonary arrest (CPA) in children, and thus the need to perform paediatric cardiopulmonary resuscitation (CPR), may arise anywhere, in or out of the hospital. The same is true of life-threatening emergencies, where immediate intervention can prevent CPA. On the other hand, errors involving equipment and medication during CPR are not infrequent and may have significant repercussions.¹ For this reason, all health care settings—be they hospitals, primary care centres or out-of-hospital urgent care and transport services—must be prepared to identify children whose life is immediately at risk in order to perform paediatric CPR and manage other life-threatening emergencies. For this to happen, the necessary material resources must be available, and health care professionals must know how to use them appropriately.

The so-called resuscitation and emergency trolleys or backpacks are an essential health care resource both in health care facilities and emergency ambulances, although the contents that need to be stocked vary depending on the setting and the expected type of CPR.²,³

However, few studies have investigated this topic, and there are no international recommendations on the equipment and medication that should be included in resuscitation trolleys, the way the trolley should be organised, or how to train health care staff on their contents and appropriate use.⁴
Table 1  Intermediate life support paediatric resuscitation trolley.

It must include the following items:

**Resuscitation**
- Automated or semi-automated external defibrillator
  - Paddles or preferably pads of adequate size for infants and older children
  - ECG monitoring cables and electrodes
  - Conductive electrode gel
- Monitoring:
  - Pulse oximeter
  - CO₂ monitor
  - Stethoscope

**Airway management and ventilation equipment:**
- Oxygen tank with pressure regulator and flow meter
- Tubing and connectors to oxygen source
- Portable suction system, manual or electric
- Suction catheters: 6-14 gauge (G)
- Oropharyngeal airways: sizes 0-5
- Face masks in various sizes for infants and children
- Self-inflating ventilation bags, 500 mL for infants and 1600-2000 mL for children, with oxygen reservoirs
- Oxygen therapy masks, with and without reservoirs
- Magill forceps: infant, child and adult sizes
- Laryngoscope with straight blades (sizes 0 and 1) and curved blades (sizes 1, 2, 3 and 4)
- Replacement batteries and laryngoscope bulbs
- Endotracheal tubes: 2.5-7.5 mm lumen, cuffed and uncuffed
- Endotracheal tube holders
- Stylets in various sizes for endotracheal tubes
- Lubricant for endotracheal tubes
- Laryngeal mask: sizes 1-4 (recommended, not mandatory)
- Nasogastric tubes: 6-14 G

**Vascular access equipment:**
- Intravenous catheters: sizes 24-14 G
- Intraosseous needles: sizes 14-18 G
- Power driver (drill) for intraosseous insertion (desirable)
- Nasal drug delivery device
- Compressor
- Syringes: 1, 5, 10 and 50 mL
- Intravenous infusion system
- 3-way stopcocks
- Sterile pads, cloths and gauze
- Antiseptic: chlorhexidine
- Immobilisation equipment
- Scalpel
- Needle holder
- Straight and curved surgical needles

**Protective equipment:**
- Protective goggles
- Gloves
- Bandages, tape
- Neck braces for infants and children

**Drugs:**
- **CPR drugs**
  - Adrenaline 0.1% (1/1000 = 1 vial = 1 mL = 1 mg)
  - Bicarbonate 1 M (1 vial = 10 mL = 10 mEq)
  - Atropine 0.1% (1 vial = 1 mL = 1 mg)
  - Amiodarone 50 mg/mL = (1 vial = 3 mL = 150 mg)
  - Lidocaine 1% (1 vial = 10 mL = 100 mg)
  - Magnesium sulfate 150 mg/mL (1 vial = 10 mL = 1500 mg = 12.2 mEq = 6.1 mmol)

- **Emergency drugs:**
A few basic principles must be taken into account to choose the materials to be included in a resuscitation trolley:

- It should only contain equipment and medication required for CPR and management of life-threatening emergencies, and its contents should only be used for these purposes.
- It should include materials suitable for children of all ages and sizes.
- It should be organised so that equipment and medication can be found easily and intuitively.

**Recommendations**

We proceed to present the recommendations on the equipment and medication for CPR made by an expert group selected by the Spanish Group on Paediatric and Neonatal CPR.

**Contents of cardiopulmonary resuscitation trolleys and backpacks**

We now describe the contents recommended for 3 types of CPR trolleys used in neonatal and paediatric care.

1. The intermediate life support paediatric resuscitation trolley, suitable for primary care clinics, after-hours care facilities, paediatric wards, paediatric outpatient clinics and radiology suites in hospitals that have a paediatric intensive care unit (PICU), as well as emergency departments in hospitals that do not usually manage children but may occasionally receive paediatric patients with CPA or life-threatening emergencies (Table 1).

2. The advanced life support trolley, suitable for PICUs, adult ICUs in hospitals without a PICU, emergency departments of hospitals with a PICU, paediatric resuscitation bays and operating theatres, and pre-hospital emergency care settings. In addition to all the materials listed for the intermediate CPR trolley, it can include the materials listed in Table 2.

3. The neonatal resuscitation trolley, which must be available in delivery rooms, neonatal intensive care units, neonatal units and emergency ambulances and transport services (Table 3).

**Recommendations for use**

The recommendations for the use of the resuscitation trolley or backpack are the following:

**Type of trolley or backpack**

Trolley: the trolley must be easy to move and have clearly visible drawers and labels. Backpack: it must be easy to carry and contain separate spaces where materials can be arranged in an organised manner.

**Location of the trolley**

It is essential for trolleys or backpacks to be stored in an easily accessible and identifiable place. Their location should be marked in some way, and they should not be concealed or blocked by any other equipment.

---

**Table 1 (Continued)**

<table>
<thead>
<tr>
<th>Contents</th>
<th>Location</th>
<th>Type of trolley</th>
</tr>
</thead>
<tbody>
<tr>
<td>Diazepam 5 mg/mL (1 vial = 2 mL = 10 mg) or midazolam (vials with 1 mg/mL and 5 mg/mL)</td>
<td>Adult ICUs, hospitals without a PICU, emergency departments of hospitals with a PICU, paediatric resuscitation bays and operating theatres, and pre-hospital emergency care settings.</td>
<td>Intermediate life support paediatric resuscitation trolley</td>
</tr>
<tr>
<td>Thiopental (vials with 0.5 and 1 g)</td>
<td></td>
<td>Advanced life support trolley</td>
</tr>
<tr>
<td>Ketamine 50 mg/mL (1 vial = 10 mL = 500 mg)</td>
<td></td>
<td>Advanced life support trolley</td>
</tr>
<tr>
<td>Etomidate 2 mg/mL (1 vial = 10 mL = 20 mg)</td>
<td></td>
<td>Advanced life support trolley</td>
</tr>
<tr>
<td>Fentanyl 50 μg/mL (1 vial = 3 mL = 150 μg) or morphine hydrochloride 1% (1 vial = 1 mL = 10 mg)</td>
<td></td>
<td>Advanced life support trolley</td>
</tr>
<tr>
<td>Succinylcholine = suxamethonium 50 mg/mL (1 vial = 2 mL = 100 mg) (refrigerated)</td>
<td></td>
<td>Advanced life support trolley</td>
</tr>
<tr>
<td>Rocuronium 10 mg/mL (1 vial = 5 mL = 50 mg) (refrigerated)</td>
<td></td>
<td>Advanced life support trolley</td>
</tr>
<tr>
<td>Adenosine (1 vial = 2 mL = 6 mg)</td>
<td></td>
<td>Advanced life support trolley</td>
</tr>
<tr>
<td>Calcium chloride 10% (1 vial = 10 mL = 182 mg of ionised calcium = 9 mEq = 4.5 mmol)</td>
<td></td>
<td>Advanced life support trolley</td>
</tr>
<tr>
<td>Hypertonic saline 50% (R50 = 1 mL = 0.5 g glucose)</td>
<td></td>
<td>Advanced life support trolley</td>
</tr>
<tr>
<td>Physiological saline 0.9% (10 and 500 mL)</td>
<td></td>
<td>Advanced life support trolley</td>
</tr>
<tr>
<td>Ringer or lactate Ringer (500 mL)</td>
<td></td>
<td>Advanced life support trolley</td>
</tr>
<tr>
<td>Distilled water (1 vial = 10 mL)</td>
<td></td>
<td>Advanced life support trolley</td>
</tr>
<tr>
<td><strong>Optional</strong></td>
<td></td>
<td>Advanced life support trolley</td>
</tr>
<tr>
<td>Glucagon 1 mg/mL (1 mL = 1 mg)</td>
<td></td>
<td>Advanced life support trolley</td>
</tr>
<tr>
<td>Naloxone 0.4 mg/mL (1 vial = 1 mL = 0.4 mg)</td>
<td></td>
<td>Advanced life support trolley</td>
</tr>
<tr>
<td>Flumazenil 0.1 mg/mL (1 vial = 10 mL = 1 mg or 5 mL = 0.5 mg)</td>
<td></td>
<td>Advanced life support trolley</td>
</tr>
<tr>
<td>Intralipid 20% (1 mL = 200 mg). Bags of 100, 250 and 500 mL</td>
<td></td>
<td>Advanced life support trolley</td>
</tr>
<tr>
<td>Sugammadex 100 mg/mL (1 vial = 2 mL = 200 mg)</td>
<td></td>
<td>Advanced life support trolley</td>
</tr>
<tr>
<td>Salbutamol nebuliser solution (1 vial = 2.5 mL = 2.5 mg)</td>
<td></td>
<td>Advanced life support trolley</td>
</tr>
<tr>
<td>6-methylprednisolone (8 mg to 1 g vials are available)</td>
<td></td>
<td>Advanced life support trolley</td>
</tr>
<tr>
<td>Propofol: 1% (1 vial = 10 mL = 10 mg) or 2% (1 vial = 10 mL = 20 mg)</td>
<td></td>
<td>Advanced life support trolley</td>
</tr>
</tbody>
</table>

Intubation equipment and drugs may be optional in some intermediate CPR trolleys.
Table 2  Advanced paediatric CPR trolley or backpack.

In addition to all items listed for the intermediate CPR trolley, it may include:

**Difficult airway equipment:**
- Laryngeal mask airways sizes 1–4
- Video laryngoscope fitting endotracheal tubes sizes 2.5–8
- Emergency cricothyrotomy kit, paediatric size

**Heimlich one-way valves**

**Pleural drainage tubes for infants and children (8–16 G)**

**Vascular access equipment**
- *Central catheters:* 4, 5.5 and 7 Fr (single, 2-way or 3-way)
- *Surgical catheterization kit:* Scalpel
  - Dissecting thumb forceps with serrated and smooth tips
  - Scissors
  - Mosquito forceps, straight and curved
  - Iris and Kocher forceps
  - Surgical blades
  - Retractors
  - Sutures: 000, 00 and 0

**Drugs:**
- Dopamine: 20 mg/5 mL vials
- Dobutamine: 250 mg/20 mL vials
- Noradrenaline: 1 mg/10 mL vials
- Calcium chloride 10%: 270 mg/10 mL vials
- Injectable magnesium sulfate solution: 1.5 g/10 mL

The CPR backpack should contain the same equipment and medication as the advanced CPR trolley, even if there are fewer units of each item.

### Contents

A cardiac arrest trolley must only include the materials required for CPR and life-threatening emergencies. Overstocking can hinder access to the materials that are actually needed to manage an emergency. All materials should be available in the sizes needed to treat children of any age.

Supplies for each device and medications should be stocked in the amounts that may be required during resuscitation. Time must not be wasted going to the storage room or pharmacy to obtain the missing items.

Each trolley and backpack should have a list with all the included equipment and medication, which can also serve as a checklist. 8

### Distribution of contents

The equipment and medication must always be organised and visible at first glance.

We recommend organising contents in drawers according to a colour-coding system or following the ABC sequence: A (airway), B (breathing) and C (circulation). 9–12

Fig. 1 shows an example of how to distribute trolley contents in the top and side trays and the different drawers.

Medications must be sealed and bear the manufacture and expiration dates.

All physicians, nurses and health care technicians must know which equipment and medications are stocked as well as their location in the trolley. 1,11,12

Table 3  Neonatal resuscitation trolley.

**General equipment:**
- Thermal cradle with source of light and heat
- Warm cloth diapers and blankets and polyethylene wrap or bag to maintain body temperature in preterm infants
- Caps
- Gloves
- Stethoscope
- Surgical tape, gauzes, cord clamp
- Antiseptic (chlorhexidine)

**Monitoring:**
- Watch
- Pulse oximeter
- Monitor de ECG

**Suction, airway, ventilation and oxygenation equipment:**
- Suction system (vacuum) with pressure regulator set to 80–100 mmHg
- Manual suction unit for neonatal backpack (out of hospital)
- Suction tubes (6, 8, 10 and 12 F)
- Sources of oxygen and air with flow metre
- Tubing and connectors to oxygen/air source
- Air/oxygen blender. Humidifier
- Face masks (different sizes: newborn, preterm and full term)
- Self-inflating bags (250, 500 mL)
- Positive pressure ventilation device: automatic or T-piece resuscitator
- Lubricant for endotracheal tubes
- Laryngoscope with straight blades sizes 00, 0 and 1
- Neonatal Magill forceps
- Endotracheal tubes sizes 2.5; 3; 3.5 and 4 mm
- Stylets
- Laryngeal mask size 1

**Equipment for vascular access:**
- Scalpel, dissection thumb forceps with smooth and serrated tips
- Umbilical tape
- Umbilical catheters sizes 3.5 and 5 Fr
- Syringes (1, 2, 5, 10 and 20 mL), 3-way stopcocks and needles
- Surgical sutures sizes 000, 00 and 0 to anchor line after resuscitation
- Angiocatheters sizes 14–20 G
- Intraosseous needle, 18 G

**Medication**
- Adrenaline 1/1000 (1/10 000 solution in normal saline)
- Bicarbonate 1 M (1 vial = 10 mL = 10 mEq), diluted in medium
- Physiological saline (NaCl 0.9%)
- Glucose (5–10%)
Checking trolley contents

A protocol must be established for checking the equipment and medications at regular intervals, assigning specific staff this responsibility, and there must be a checklist for testing the equipment and restocking materials. The equipment and medications must always be reviewed after performance of CPR.

The contents of the trolley should never be used for anything other than CPR and life-threatening emergencies.

Staff training

All physicians, nurses and health care technicians must be trained and updated periodically not only on paediatric and neonatal CPR techniques, but also on the equipment and drugs included the trolley and their use during CPR.

Dosage sheets

It is recommended that the following be placed in a highly visible location with the resuscitation trolley:

- A sheet with the size of each equipment item and dosage of each medication recommended for each age and weight in children.
- A checklist of all the equipment and medication included in the trolley.
- A sheet or poster with the paediatric CPR algorithm (intermediate or advanced, as applicable).

Conflicts of interest

The authors have no conflicts of interest to declare.

References