

SPECIAL ARTICLE

## Materials for the paediatric resuscitation trolley or backpack: Expert recommendations<sup>☆</sup>



Jesús López-Herce Cid<sup>a,\*</sup>, Antonio Rodríguez Núñez<sup>b</sup>, Ángel Carrillo Álvarez<sup>c</sup>, Gonzalo Zeballos Sarrato<sup>d</sup>, Cecilia Martínez Fernández-Llamazares<sup>e</sup>, Custodio Calvo Macías<sup>f</sup>, Grupo Español de Reanimación Cardiopulmonar Pediátrica y Neonatal

<sup>a</sup> Servicio de Cuidados Intensivos Pediátricos, Hospital General Universitario Gregorio Marañón de Madrid, Instituto de investigación sanitaria del Hospital Gregorio Marañón, Facultad de Medicina, Universidad Complutense de Madrid, Grupo Español de Reanimación Cardiopulmonar Pediátrica y Neonatal, Red de Salud Maternoinfantil y del Desarrollo (RedSAMID), RETICS financiada por el PN I + D + I 2008-2011, ISCIII – Subdirección General de Evaluación y Fomento de la Investigación y el Fondo Europeo de Desarrollo Regional (FEDER), ref. RD16/0022, Spain

<sup>b</sup> Área de Pediatría, Servicio de Críticos, Intermedios y Urgencias Pediátricas, Hospital Clínico Universitario de Santiago de Compostela, Departamento de Radiología, Psiquiatría, Salud Pública, Enfermería y Medicina de la Universidad de Santiago de Compostela (USC), Grupos de Investigación CLINURSID (USC) y Soporte Vital y Simulación (Instituto de Investigación de Santiago), Instituto de Investigación de Santiago (IDIS), Red de Salud Maternoinfantil (SAMID II), RETICS financiada por el PN 2018-2011, el ISCIII-Subdirección General de Evaluación y Fomento de la Investigación y el Fondo Europeo de Desarrollo Regional (FEDER) ref: RD16/0022, Spain

<sup>c</sup> Servicio de Cuidados Intensivos Pediátricos, Hospital General Universitario Gregorio Marañón de Madrid, Instituto de investigación sanitaria del Hospital Gregorio Marañón, Facultad de Medicina. Universidad Complutense de Madrid. Grupo Español de Reanimación Cardiopulmonar Pediátrica y Neonatal, Red de Salud Maternoinfantil y del Desarrollo (RedSAMID), RETICS financiada por el PN I + D + I 2008-2011, ISCIII - Subdirección General de Evaluación y Fomento de la Investigación y el Fondo Europeo de Desarrollo Regional (FEDER), ref. RD16/0022, Spain

<sup>d</sup> Servicio de Neonatología, Hospital General Universitario Gregorio Marañón de Madrid, Instituto de investigación sanitaria del Hospital Gregorio Marañón, Grupo Español de Reanimación Cardiopulmonar Pediátrica y Neonatal, Spain

<sup>e</sup> Servicio de Farmacia, Hospital General Universitario Gregorio Marañón de Madrid, Instituto de investigación sanitaria del Hospital Gregorio Marañón, Red de Salud Maternoinfantil y del Desarrollo (RedSAMID), RETICS financiada por el PN I + D + I 2008-2011, ISCIII – Subdirección General de Evaluación y Fomento de la Investigación y el Fondo Europeo de Desarrollo Regional (FEDER), ref. RD16/0022, Spain

<sup>f</sup> Emérito SAS, Asociado a UGC Críticos y Urgencias Pediátricas, Hospital Regional Universitario de Málaga, Grupo Español de Reanimación Cardiopulmonar Pediátrica y Neonatal, Spain

Received 20 March 2017; accepted 25 May 2017

### KEYWORDS

Cardiopulmonary resuscitation;

**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

<sup>☆</sup> Please cite this article as: López-Herce Cid J, Rodríguez Núñez A, Carrillo Álvarez Á, Zeballos Sarrato G, Martínez Fernández-Llamazares C, Calvo Macías C, et al. Recomendaciones de expertos sobre el material del carro y mochila de reanimación cardiopulmonar pediátrica y neonatal. An Pediatr (Barc). 2018;88:173.e1-173.e7.

\* Corresponding author.

E-mail address: [pielvi@hotmail.com](mailto:pielvi@hotmail.com) (J. López-Herce Cid).

\*\* Life support material;  
Resuscitation organisation;  
Resuscitation trolley;  
Children;  
Newborn

material ready to resuscitate a child. These recommendations are the consensus of experts of the Spanish Paediatric and Neonatal Resuscitation Group on the material and medication for paediatric and neonatal resuscitation and their distribution and use.

CPR trolleys and backpacks must include the essential material to quickly and efficiently perform a paediatric CPR. At least one CPR trolley must be available in every Primary Care facility, Paediatric Intensive Care Unit, Emergency Department, and Pre-hospital Emergency Areas, as well as in paediatric wards, paediatric ambulatory areas, and radiology suites. This trolley must be easily accessible and exclusively include the essential items to perform a CPR and to assist children (from newborns to adolescents) who present with a life-threatening event. Such material must be familiar to all healthcare staff and also include the needed spare parts, as well as enough drug doses. It must also be re-checked periodically.

The standardisation and unification of the material and medication of paediatric CPR carts, trolleys, and backpacks, as well as the training of the personnel in their use are an essential part of the paediatric CPR.

© 2017 Asociación Española de Pediatría. Published by Elsevier España, S.L.U. All rights reserved.

## PALABRAS CLAVE

Reanimación cardiopulmonar;  
Material de reanimación;  
Organización de la reanimación;  
Carro de reanimación;  
Niños;  
Recién nacidos

## Recomendaciones de expertos sobre el material del carro y mochila de reanimación cardiopulmonar pediátrica y neonatal

**Resumen** La parada cardiorrespiratoria (PCR) se puede presentar en cualquier lugar y en cualquier momento y por ello todos los centros sanitarios y los servicios de urgencias extrahospitalarias deben disponer de personal y material adecuado para realizar una reanimación cardiopulmonar (RCP). Estas recomendaciones son el consenso de expertos del Grupo Español de Reanimación Cardiopulmonar Pediátrica y Neonatal sobre el material y medicación de RCP pediátrica y neonatal y su distribución y utilización.

Los carros y mochilas de RCP deben tener el material y la medicación para llevar a cabo de forma rápida y eficiente una RCP pediátrica. Debe existir al menos un carro de RCP accesible en cada centro de atención primaria, unidad de cuidados intensivos pediátricos, unidad de cuidados intensivos neonatales, servicio de urgencias, servicio de urgencias extrahospitalarias, planta de pediatría, área de consultas y zona de radiología. El carro de RCP debe contener solo el material y la medicación imprescindibles para realizar una RCP y atender a las urgencias vitales. El material debe ser conocido por el personal, incluir los repuestos necesarios y ser revisado y repuesto periódicamente.

La estandarización y unificación del contenido (material y medicación) de los carros y mochilas de RCP pediátrica, así como el entrenamiento del personal en su utilización, son una parte esencial de la organización asistencial de la RCP pediátrica.

© 2017 Asociación Española de Pediatría. Publicado por Elsevier España, S.L.U. Todos los derechos reservados.

## 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.<sup>1</sup> 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.<sup>2,3</sup>

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.<sup>4</sup>

**Table 1** Intermediate life support paediatric resuscitation trolley.

It must include the following items:

**Resuscitation**

*Automated or semi-automated external defibrillator* *with:*

- Paddles or preferably pads of adequate size for infants and older children
- ECG monitoring cables and electrodes
- Conductive electrode gel

*Monitoring:*

- Pulse oximeter
- CO<sub>2</sub> 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:*

Table 1 (Continued)

Diazepam 5 mg/mL (1 vial = 2 mL = 10 mg) or midazolam (vials with 1 mg/mL and 5 mg/mL)
Thiopental (vials with 0.5 and 1 g)
Ketamine 50 mg/mL (1 vial = 10 mL = 500 mg)
Etomidate 2 mg/mL (1 vial = 10 mL = 20 mg)
Fentanyl 50 µg/mL (1 vial = 3 mL = 150 µg) or morphine hydrochloride 1% (1 vial = 1 mL = 10 mg)
Succinylcholine = suxamethonium 50 mg/mL (1 vial = 2 mL = 100 mg) ( <i>refrigerated</i> )
Rocuronium 10 mg/mL (1 vial = 5 mL = 50 mg) ( <i>refrigerated</i> )
Adenosine (1 vial = 2 mL = 6 mg)
Calcium chloride 10% (1 vial = 10 mL = 182 mg of ionised calcium = 9 mEq = 4.5 mmol)
Hypertonic glucose 50% (R50 = 1 mL = 0.5 g glucose)
Physiological saline 0.9% (10 and 500 mL)
Ringer or lactate Ringer (500 mL)
Distilled water (1 vial = 10 mL)
<i>Optional</i>
Glucagon 1 mg/mL (1 mL = 1 mg)
Naloxone 0.4 mg/mL (1 vial = 1 mL = 0.4 mg)
Flumazenil 0.1 mg/mL (1 vial = 10 mL = 1 mg or 5 mL = 0.5 mg)
Intralipid 20% (1 mL = 200 mg). Bags of 100, 250 and 500 mL
Sugammadex 100 mg/mL (1 vial = 2 mL = 200 mg)
Salbutamol nebuliser solution (1 vial = 2.5 mL = 2.5 mg)
6-methylprednisolone (8 mg to 1 g vials are available)
Propofol: 1% (1 vial = 10 mL = 10 mg) or 2% (1 vial = 10 mL = 20 mg)

Intubation equipment and drugs may be optional in some intermediate CPR trolleys.

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<sup>5-7</sup> (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 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.<sup>8</sup>

**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).<sup>9–12</sup>

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

**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%)

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.<sup>2,11,12</sup>

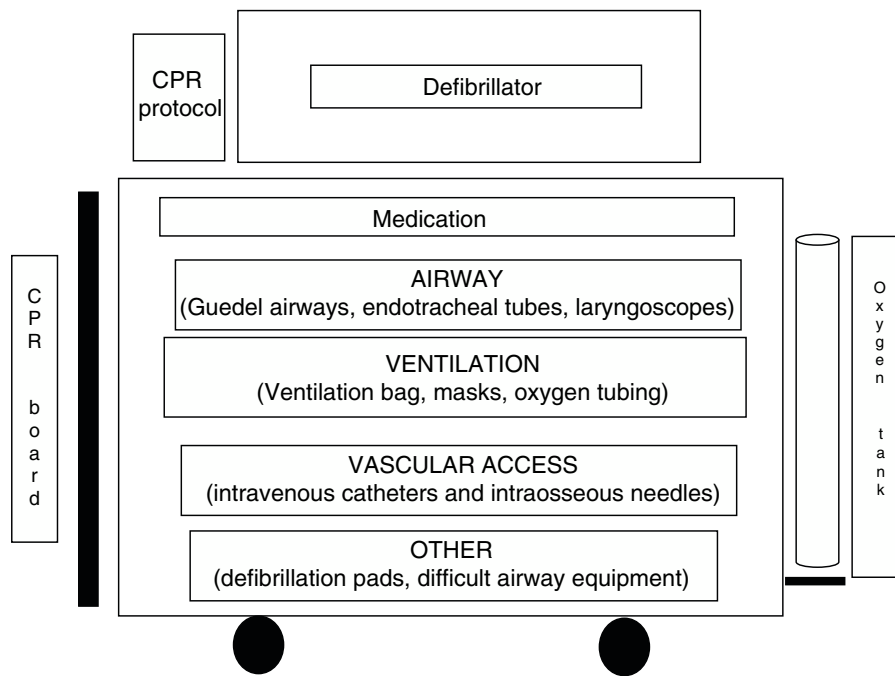


Figure 1 Example of the organisation of a cardiopulmonary resuscitation trolley.

### 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

1. Flannery AH, Parli SE. Medication errors in cardiopulmonary arrest and code-related situations. *Am J Crit Care.* 2016;25:12–20.
2. Calvo C, López-Herce J, Carrillo A, Burón E, Grupo Español de Reanimación Cardiopulmonar Pediátrica y Neonatal. Material de reanimación cardiopulmonar pediátrica en el carro de parada o mesa de reanimación. *An Esp Pediatr.* 2007;66:51.
3. Bowden T, Smith D. An overview of adult cardiopulmonary resuscitation equipment. *Nurs Stand.* 2017;31:54–63.
4. Rodríguez-Núñez A, López-Herce Cid J, Calvo Macías C, Carrillo Álvarez A. Do we need guidelines for pediatric resuscitation carts/trolleys/backpacks content and management? *Resuscitation.* 2017;114:e19–20.
5. Chan J, Chan B, Ho HL, Chan KM, Kan PG, Lam HS. The neonatal resuscitation algorithm organized cart is more efficient than the airway-breathing-circulation organized drawer: a crossover randomized control trial. *Eur J Emerg Med.* 2016;23:258–62.
6. Chitkara R, Rajani AK, Lee HC, Snyder Hansen SF, Halamek LP. Comparing the utility of a novel neonatal resuscitation cart with a generic code cart using simulation: a randomised, controlled, crossover trial. *BMJ Qual Saf.* 2015;22:124–9.
7. Zeballos Sarrato G, Salguero García E, Aguayo Maldonado J, Gómez Robles C, Thió Lluch M, Iriondo Sanz M, et al. Adaptación de las recomendaciones internacionales en estabilización y reanimación neonatal 2015. *An Pediatr (Barc).* 2017;86:51.e1–9.
8. Davies M, Couper K, Bradley J, Baker A, Husselbee N, Woolley S, et al. A simple solution for improving reliability of cardiac arrest equipment provision in hospital. *Resuscitation.* 2014;85:1523–6.
9. Stevens AD, Hernandez C, Jones S, Moreira ME, Blumen JR, Hopkins E, et al. Color-coded prefilled medication syringes decrease time to delivery and dosing errors in simulated prehospital pediatric resuscitations: a randomized crossover trial. *Resuscitation.* 2015;96:85–91.

10. Rousek JB, Hallbeck MS. Improving medication management through the redesign of the hospital code cart medication drawer. *Hum Factors*. 2011;53:626–36.
11. Agarwal S, Swanson S, Murphy A, Yaeger K, Sharek P, Halamek LP. Comparing the utility of a standard pediatric resuscitation cart with a pediatric resuscitation cart based on the Broselow tape: a randomized, controlled, crossover trial involving simulated resuscitation scenarios. *Pediatrics*. 2005;116:e326–33.
12. Maul E, Latham B, Westgate M. Saving time under pressure: effectiveness of standardizing pediatric resuscitation carts. *Hosp Pediatr*. 2016;6:67–71.