Paediatric Handbook

9TH EDITION

The Royal Children's Hospital Melbourne

Amanda Gwee, Romi Rimer and Michael Marks

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Paediatric Handbook

NINTH EDITION

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Foreword

Since it was first published in January 1964, the *Royal Children's Hospital Handbook* has provided invaluable guidance to clinicians managing health problems in children. Although this primary purpose has not changed since the first edition, the Handbook itself has changed greatly. The 1964 edition consisted of only 100 pages in a ring binder, so individual sections could be updated from year to year. It was called the *Resident Medical Officers' Handbook* and it slipped easily into the pocket of a white coat for, in 1964, Junior Medical Staff, as they were called, actually wore white coats and resided at the Hospital.

It may have been a convenient size, but the first edition made no mention of upper or lower respiratory tract infections, fever, asthma or convulsions, and cardiac disease was covered in two pages that were mainly about digoxin. Subsequent editions were more systematic; they provided practical guidance about the management of the common illnesses of children, including paediatric emergencies and the common causes of admission to hospital. From the 1989 edition onwards, there was an index so that information was easier to find, and sources of more detailed material were suggested. The eighth edition of 640 pages was published in 2009, by which time the Handbook had become so useful that it was widely used, not just at the Royal Children's Hospital, but throughout the world.

To make this ninth edition even more useful in clinical practice, it has been redesigned for easier navigation and updated with many more links to practice guidelines. The Handbook is now 50 years old, and it has matured into an extraordinarily useful resource. We are lucky to have it – and so are the children.

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Preface

We are very excited and proud to present the ninth edition of the Royal Children's Hospital *Paediatric Handbook*. The Royal Children's Hospital moved to an outstanding new building in November 2011. This edition is the first to be published since the move, with the front cover displaying some of the artistic beauty that lies within the "Main Street". Just as our new campus has been given a fresh look, so too this edition has taken a fresh approach on an already popular resource for medical students, general practitioners, paediatricians and other health professionals alike.

There are many improvements and updates in the latest edition. First, the Handbook is ordered with chapters according to systems. This will make it easier and more intuitive for clinicians to readily access the information they require about a given problem. In addition, the Handbook is now more closely aligned with the *Royal Children's Hospital Clinical Practice Guidelines*, which remains the most popular paediatric website in the Southern Hemisphere.

Some of the other new features include:

- Evidence-based information with revisions in all chapters of this Handbook
- The addition of a genetics chapter
- Completely new renal chapter
- Completely new oncology chapter
- Updated drug doses
- Electronic version of the Handbook

This Handbook was written collectively by a multitude of staff from the Royal Children's Hospital in Melbourne, including doctors, nurses and allied health. The authors are greatly respected clinicians in their fields and we are grateful for their time, effort and expertise, which has resulted in this world-class paediatric aid. We also sincerely appreciate the efforts of previous authors who laid the foundations for such a key resource. Special thanks to Professor Frank Shann for permitting us to utilise his drug doses book. The PDA version of this reference will be available in its entirety at www.drugdoses.net

Lastly, to the enthusiastic and dedicated editorial committee, thank you so much for your mammoth efforts in putting together this Handbook. Your support and assistance are greatly appreciated.

One of the great things about paediatrics, and indeed medicine in general, is that it is ever changing. So, whilst the information in this Handbook is up to date at the time of printing, we encourage our readers to continue to read the literature and check drug doses before administration.

Thank you, the readers, for your support of this paediatric handbook. We trust that you will find this a very important and useful tool when looking after the children of the world.

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CHAPTER 1

Medical emergencies

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Ed Oakley
James Tibballs

Cardiorespiratory arrest

Cardiorespiratory arrest may occur in a wide variety of conditions that cause hypoxaemia or hypotension, or both.

The initial cardiac rhythm discovered during early resuscitation is often severe bradycardia or asystole. Although the spontaneous onset of ventricular fibrillation in children is approximately 10%, it may occur more frequently with congenital heart conditions or secondary to poisoning with cardioactive drugs. In hospital, respiratory arrest alone is more common than cardiorespiratory arrest.

Diagnosis and initial management

- Cardiorespiratory arrest may be suspected when the patient becomes unresponsive or unconscious, is not moving or breathing normally or appears pale or cyanosed. Call for help immediately.
- Assess airway and respiration by observing movement of the chest, as well as listening and feeling for expired breath while positioning the head and neck to open and maintain an airway. Movement of the chest without expiration indicates a blocked airway.
- DO NOT delay resuscitation while feeling for a pulse. Start compressions in the presence of bradycardia before the pulseless state or if other signs of circulation (adequate ventilation, movement, consciousness) are absent.
- Whenever possible, manage in a treatment room. Carry the patient there if necessary. If this is not possible, get the resuscitation trolley brought to the patient.
- Cardiopulmonary resuscitation (CPR) must commence with basic techniques and be continued using advanced techniques (Fig. 1.1).

Airway maintenance and ventilation

- If airway obstruction is present, quickly inspect the pharynx. Clear secretions or vomitus by brief suction using a Yankauer sucker.
- Maintain the airway with backward head tilt, chin lift or forward jaw thrust.
- If adequate spontaneous ventilation does not resume, ventilate the lungs mechanically with a self-inflating resuscitator (e.g., Laerdal, Ambu, Air-viva) with added oxygen 8–10 L/min. If ventilation cannot be achieved with the resuscitator, use a mouth-to-mask technique. Give two initial breaths.
  Note: Self-inflating bags (e.g., Laerdal) will provide no gas flow to the patient unless they are compressed cyclically.
- **Whatever technique is used, ensure that ventilation expands the chest adequately.**
- Intubate the trachea via the mouth if possible, but do not cause hypoxaemia by prolonged unsuccessful attempts. Select the tube and insert it at a depth appropriate to the patient's age in years.

Endotracheal tube size and position

- Uncuffed tube size (internal diameter) = (age/4) + 4 mm (for patients over 1 year of age)
- Cuffed tube size (internal diameter) = (age/4) + 3.5 mm (for patients over 1 year of age)
- Depth of insertion is approximately (age/2) + 12 cm from the lower lip

  Neonates: see Neonatal Conditions (Table 21.1).

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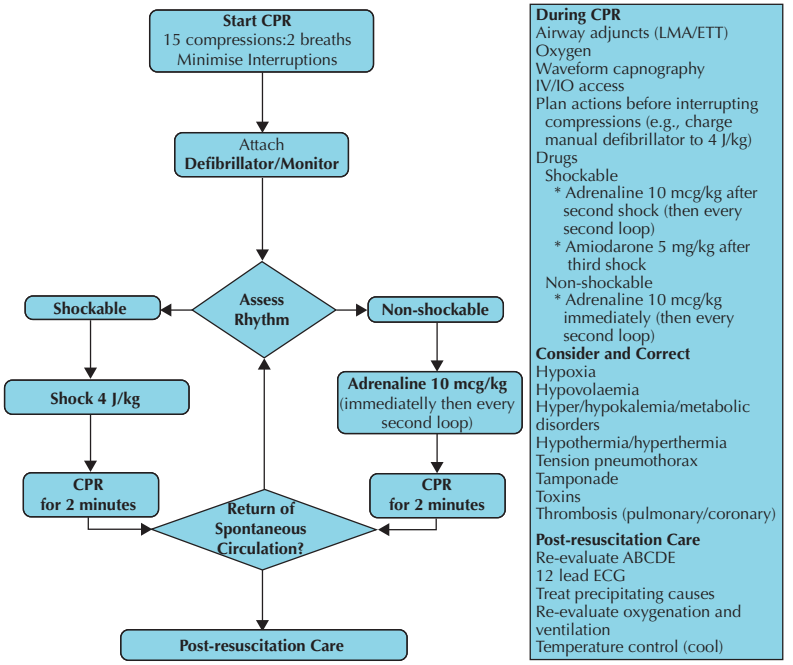

Fig. 1.1 Management of cardiorespiratory arrest. Adapted from guidelines at www.nzrc.org.nz/guidelines.

Secure the tube with cotton tape around the neck or affix it firmly to the face with adhesive tape to avoid endobronchial intubation or accidental extubation. Confirm placement by detecting end-tidal CO_2.

External cardiac compression

Start external cardiac compression (ECC) over the lower sternum if

- A pulse is not palpable within 10 seconds
- A pulse is less than
  - 60 beats/min (for infants)
  - 40 beats/min (for older children)
- Other signs of circulation (adequate ventilation, movement, consciousness) are absent

Place the patient on a firm surface and depress the lower sternum one-third the depth of the chest whilst avoiding pressure over the ribs and abdominal viscera:

- Newborn infant or an infant (<1 year) – two-thumb technique in which the hands encircle the chest
- Small child (1–8 years) – the heel of one hand
- Larger child (>8 years) and adult – the two-handed technique

Compression–ventilation rates and ratios

The rates and ratios recommended for health-care rescuers by the Australian Resuscitation Council (www.resus.org.au) are shown in Table 1.1. Use a ratio of 30:2 if a sole rescuer or 15:2 when two rescuers are present.

Table 1.1 Compression–ventilation ratios

	Give two initial breaths, then	
	One rescuer (expired air resuscitation) Compression:breaths	**Two rescuers (bag–mask ventilation) Compression:breaths**
Newborn infants	3:1	3:1
Infants (<1 year old)	30:2	15:2
Small children (1–8 year old)	30:2	15:2
Larger children (>8 year old)	30:2	15:2
Adults	30:2	30:2

Source: From the Australian Resuscitation Council. Adapted from guidelines at www.resus.org.au/policy/guidelines.

When using bag-to-mask ventilation or mouth-to-mask ventilation, the rescuer giving compressions should count aloud to allow the rescuer giving ventilation to deliver effective breaths during pauses between compressions with minimal interruption in compressions. Compression may be commenced at the end of inspiration. If the patient is intubated, DO NOT interrupt compressions. The *rate* of compressions should be 100/min.

If ventilation is given by bag and ETT, ECC may be continued during ventilation, provided lung expansion can be achieved. In this circumstance, restrict the number of ventilations to about 10/min. Aim for an end-tidal CO_2 of >15 mmHg.

Management of cardiac dysrhythmias

Determine the cardiac rhythm with defibrillator paddles or pads or chest leads.

- Give a single 4 J/kg DC shock if ventricular fibrillation or pulseless ventricular tachycardia is present. See Table 1.1 and Fig. 1.1.
- Give adrenaline if any other pulseless rhythm is present (see Fig. 1.1). The dose is
  - IV and intraosseous: 10 mcg/kg (0.01 mL of 1:1000 solution).
  - Endotracheal tube (ETT): 100 mcg/kg (0.1 mL of 1:1000 solution).
- Insert an IV cannula. Although this is the preferred access to the circulation, do not waste time (>90 seconds) with repeated unsuccessful attempts, as access can be achieved with the alternative techniques of
  - *Intraosseus administration* (see Chapter 4, *Procedures*, p. 36): all IV drugs and resuscitation fluids can be given via this route.
  - *ETT administration*: only adrenaline, atropine and lignocaine (lidocaine) can be given this way; this is the least effective method.
- A quick reference guide to drug doses and fluid volume is provided in Table 1.2.

Other drugs

Amiodarone

This is the only antidysrhythmic shown to be of benefit for VT/VF. The dose is 5 mg/kg given as a bolus. It can cause hypotension.

Calcium

This is a useful inotropic and vasopressor agent but has no place in the management of a dysrhythmia, unless it is caused by hypocalcaemia, hyperkalaemia or calcium channel blocker toxicity. It is not useful and probably harmful for asystole, ventricular fibrillation or electromechanical dissociation. The IV dose is 10% calcium chloride (0.2 mL/kg) or 10% calcium gluconate (0.7 mL/kg). Do not administer calcium via ETT and do not mix it with bicarbonate.

Adenosine

This is the preferred drug treatment (200 mcg/kg IV) for supraventricular tachycardia (SVT). See management of SVT in Chapter 6, *Cardiac conditions*, p. 64.

Table 1.2 Table of drugs, fluid volume, endotracheal tubes and direct current shock for paediatric resuscitation

Age	0	2 months	5 months	1 year	2 years	3 years	4 years	5 years	6 years	7 years	8 years	9 years	10 years	11 years	12 years	13 years	14 years
Bodyweight (kg)[a]	**3.5**	**5**	**7**	**10**	**12**	**14**	**16**	**18**	**20**	**22**	**25**	**28**	**32**	**36**	**40**	**46**	**50**
Height (cm)[a]	**50**	**58**	**65**	**75**	**85**	**94**	**102**	**109**	**115**	**121**	**127**	**132**	**138**	**144**	**151**	**157**	**162**
Adrenaline 1:1000 (mL)																	
10 mcg/kg	0.035	0.05	0.07	0.10	0.12	0.14	0.16	0.18	0.2	0.22	0.25	0.28	0.32	0.36	0.4	0.46	0.5
100 mcg/kg	0.35	0.5	0.7	1	1.2	1.4	1.6	1.8	2	2.2	2.5	2.8	3.2	3.6	4	4.6	5
Adrenaline 1:10,000 (mL)																	
10 mcg/kg	0.35	0.5	0.7	1	1.2	1.4	1.6	1.8	2	2.2	2.5	2.8	3.2	3.6	4	4.6	5
100 mcg/kg	3.5	5.0	7.0	10	12	14	16	18	20	22	25	28	32	36	40	46	50
Lignocaine (lidocaine) 1% (mL)																	
1 mg/kg	0.3	0.5	0.7	1.0	1.2	1.4	1.6	1.8	2.0	2.2	2.5	2.8	3.2	3.6	4.0	4.6	5.0
Sodium bicarbonate 8.4% (mL)																	
1 mmol/kg	3.5	5	7	10	12	14	16	18	20	22	25	28	32	36	40	46	50
Fluid volume (mL)																	
20 mL/kg	70	100	140	200	240	280	320	360	400	440	500	560	640	720	800	920	1000
Endotracheal tube																	
Size (mm) Age/4 + 4	3	3.5	3.5	4	4.5	4.5	5	5	5.5	5.5	6	6	6.5	6.5	7	7	7.5
Oral length (cm) Age/2 + 12	9.5	11	11.5	12	13	13.5	14	14.5	15	15.5	16	16.5	17	17.5	18	18.5	19
Direct current shock (J) unsynchronised																	
VF, VT 2 J/kg	7	10	20	20	20	30	30	30	50	50	50	50	70	70	70	100	100
VF, VT 4 J/kg	10	20	30	50	50	50	70	70	70	100	100	100	150	150	150	200	200
Direct current shock (J) synchronised																	
SVT 1 J/kg	3	5	7	10	10	10	20	30	20	20	30	30	30	30	50	50	50

Source: Oakley P, Phillips B, Molyneaux E, & Mackway-Jones K. (1993) Paediatric resuscitation. Updated standard reference chart. *British Medical Journal* 1993;306(6892):1613. (Oakley 1993. Reproduced with permission by BMJ.)

[a] 50th percentiles.

Extracorporeal cardiopulmonary resuscitation – extracorporeal life support

Centres with the capacity to provide paediatric cardiopulmonary bypass should consider the role of extracorporeal life support. ECLS for refractory cardiac arrest has been associated with increased survival. At RCH this is usually reserved for in-hospital arrests.

Post-resuscitation care

- Ensure adequate ventilation and normocarbia.
- Maintain adequate blood pressure with infusion of fluids and inotropic support as needed.
- Do not actively rewarm. If the child remains unconscious after resuscitation, institute therapeutic hypothermia to 33–34°C within 6 hours for 2–3 days.

Anaphylaxis

See also Chapter 19, *Allergy and immunology*.

The life-threatening clinical manifestations are

- Hypotension secondary to vasodilatation and loss of plasma volume due to increased capillary permeability
- Bronchospasm
- Upper airways obstruction due to laryngeal or pharyngeal oedema

Immediate treatment

- Vasopressor and bronchodilator therapy: give adrenaline 10 mcg/kg (0.01 mg/kg) at 0.01 mL/kg of 1:1000 solution by **intramuscular (IM)** injection or 0.01 mg/kg (i.e. 0.1 mL/kg of 1:10,000 solution) by slow IV injection (over 10 minutes). A continuous infusion (0.1–1.0 mcg/kg/min) may be required if manifestations are prolonged. *Note*: Do *not* use subcutaneous adrenaline as absorption is less reliable.
- Oxygen by mask: mechanical ventilation may be required.
- IV volume expander: give 0.9% saline at 20 mL/kg. Give repeat boluses of 10–20 mL/kg until the blood pressure is restored.
- Bronchodilator therapy with salbutamol: continuous nebulised (0.5%) or IV 5 mcg/kg/min for 1 hour, then 1 mcg/kg/min thereafter. Secondary therapy with a steroid, aminophylline and an antihistamine may be helpful for prolonged bronchospasm and capillary leak.
- Relief of upper airway obstruction: mild to moderate oedema may respond to inhalation of nebulised 1% adrenaline (1 mL per dose diluted to 4 mL) or 5 mL of nebulised 1:1000 solution, but intubation of the trachea may be required.
- Anaphylaxis can be biphasic and the patient may deteriorate again over the next few hours.
- All patients with anaphylaxis should be observed carefully for at least 12 hours, followed up for allergen testing, provided with self-injectable adrenaline and a Medi-alert bracelet.
- Refractory anaphylaxis has been shown to respond to both noradrenaline and vasopressin infusions. These will require central venous access.
- If drug-mediated anaphylaxis is suspected, a mast cell tryptase (serum tube) should be taken ideally between 1 and 4 hours after the reaction (earlier if hymenoptera (bee) sting suspected).
- See http://www.allergy.org.au

Septicaemic shock

Hypotension is due to vasodilatation, (early) leakage of fluid from capillary beds and depression of myocardial contractility.

- Collect blood for culture, but do not delay administration of an **antibiotic** if a blood sample cannot be collected.
  - Unknown pathogen: give flucloxacillin 50 mg/kg (max 2 g) IV 4 hourly and cefotaxime 50 mg/kg (max 2 g) IV 6 hourly.
  - Meningococcaemia: give cefotaxime 50 mg/kg (max 2 g) IV 6 hourly. Give benzylpenicillin 60 mg/kg (max 3 g) IV/IM 4 hourly if cefotaxime is not available.
  - For particular circumstances, consult the Appendix 3, *Antimicrobial Guidelines*.
- Treat shock with **0.9% saline solution**, 20 mL/kg initially (further boluses of 10–20 mL/kg may be needed).
- Give **oxygen** and monitor blood gases. Mechanical ventilation may be required.