Preface

For most health professionals, few events are more challenging or stressful than caring for a sick or preterm baby. It is therefore not surprising that the management and stabilization of these babies is repeatedly identified as a priority for new educational programs. The Acute Care of at-Risk Newborns (ACoRN) program was developed in response to this need. It is designed for any practitioner who may be called upon to care for at-risk babies and their families, regardless of experience or training in neonatal emergencies.

ACoRN provides a systematic approach to the identification and management of babies requiring stabilization. It serves as the foundation for an educational program that aims to teach the concepts and basic skills of neonatal stabilization and where necessary, preparation for transport to a referral facility. The ACoRN process applies to babies who need assistance in the transition from fetal life, and babies who become unwell or are at risk of becoming unwell in the first few hours or days after birth.

Through the creative efforts of individuals with diverse educational backgrounds and clinical practices, an innovative textbook has evolved that is designed to help the practitioner gather and organize information, establish priorities, and initiate interventions aimed at delivering a level of care that results in the best possible outcome.

ACoRN combines evidence- and consensus-based guidelines and acknowledges the clinical wisdom of those who have taught this material to health care professionals for many years. As new practices evolve, there will undoubtedly be changes and improvements in newborn care. We invite your comments and encourage constructive feedback for incorporation into future editions.

The ACoRN Neonatal Society
Overview

What is ACoRN?

The Acute Care of at-Risk Newborns (ACoRN) is a priority-based, clinically oriented framework that sequentially integrates assessment, monitoring, diagnostic evaluation, intervention, and on-going management for at-risk and unwell newborns. ACoRN is also appropriate for further stabilization of babies who have been resuscitated at birth.

As the baby’s condition changes and more information is collected during the process of stabilization, all components of the framework are systematically revisited.

What are the objectives of the ACoRN program?

The objectives of the ACoRN program are to:
1. Identify the at-risk or unwell baby who will benefit from the ACoRN process.
2. Determine whether the baby needs to be resuscitated immediately.
3. Conduct a systematic evaluation of the baby.
4. Develop working diagnoses and institute specific treatments for acute neonatal conditions.
5. Describe the types of support that may be required by the baby, the family, and the health care team.
6. Identify resources available for newborn care in local and referral facilities.
7. Identify and prepare babies who require transport to a referral facility.

What is the ACoRN textbook?

The textbook illustrates the ACoRN process and adds knowledge sequentially, chapter by chapter, and case by case.

In order to derive the greatest benefit, the textbook should be read from start to finish, within the context of the professional roles, responsibilities and level of training of the learner.

How are the chapters designed?

Each chapter is designed to illustrate the ACoRN process around one area of interest. All chapters contain:
- Learning Objectives, Key Concepts and a list of Skills required for the chapter
- Introduction
- The ACoRN Sequence specific to the area of interest being covered
- Core content specific to the ACoRN Sequence
- Illustrative case studies to advance the reader, step by step, through the ACoRN Process and to provide additional content
- Questions to reinforce previously presented content, or to introduce new knowledge
- Bibliography
This ACoRN symbol appears at various places throughout the text to introduce a particular skill that may require review.

The ACoRN symbol directs you to the Skills section in the Appendix where practical and technical information about that skill is provided.

In this textbook, the NRP logo indicates resuscitation skills\(^1\) that are taught by the AAP/AHA Neonatal Resuscitation Program. These skills are included with an ACoRN perspective for the purpose of providing a review for professionals with current training in NRP. Review or completion of this Appendix does not constitute an NRP activity.

**What is in the Appendices?**

The Appendices of the ACoRN textbook contains the following additional information:

- Neonatal Assessment Tool: A sample assessment tool is provided for easy reference and documentation of clinical findings.
- Neonatal Resuscitation Skills
- Procedures
- Interpretation of Investigations
- Medications.

**What is the ACoRN workshop?**

The ACoRN workshop is an interactive session that utilizes case-based learning and practice stations to apply the concepts and skills presented in the textbook.

Learners are encouraged to participate in an ACoRN workshop in addition to reading this textbook.

The workshops should be designed to best meet the specific needs of the learners by the prior identification of the content and specific skills that will need to be emphasized and reviewed. Administration of a prior-learning assessment tool and identification of institutional objectives assist the ACoRN Education Team to tailor the design of each workshop.

Like neonatal resuscitation, stabilization is most effective when performed by a coordinated team. Teamwork and an interdisciplinary approach are emphasized along with sharing of clinical scenarios.

**Are there pre-requisites to participate in an ACoRN workshop?**

ACoRN assumes familiarity with the American Academy of Pediatrics/American Heart Association’s Neonatal Resuscitation Program (NRP) at the provider level.

---

\(^1\) All NRP diagrams reproduced in ACoRN have been kindly provided by the American Academy of Pediatrics (AAP) / American Heart Association (AHA).
A brief review of core knowledge and skills in neonatal resuscitation is integrated into the ACoRN textbook and workshop.

In preparation for an ACoRN workshop, participants are asked to read the complete ACoRN textbook, or the sections pertaining to the workshop being offered. This preparation should always include a thorough understanding of Chapter 1, and a review of the eight Sequences as they apply to the professional roles, responsibilities and level of training of the learners.

The objective of the ACoRN education program is not to memorize the textbook but to understand the ACoRN process, its application in the clinical setting, and to learn how to use the textbook as a resource.

The Skills section of the Appendices contain information on equipment, procedures and medications. These should be reviewed as applicable to the workshop being offered and the roles and responsibilities of the learners.

Does workshop completion imply clinical competence?

Participation in an ACoRN workshop does not imply the participant has achieved clinical competence. The responsibility to determine the readiness of an individual for their clinical responsibilities belongs to the institution and professional organization with which the learner is associated.

An ACoRN workshop is a learning experience. At the conclusion of a workshop, participants are asked to complete a case-based evaluation of key ACoRN concepts (for example, how to apply the Primary Survey). The evaluation may also include demonstration of knowledge and skills using simulations or models.

Do I get CME credit for completing an ACoRN program?

ACoRN workshops can be designed to comply with the requirements set by professional organizations to provide their members with educational credits. Regional networks and/or professional organizations are encouraged to apply for continuing professional education credits for participants in an ACoRN workshop.
Standard Precautions

Health care providers are advised to use standard precautions against disease transmission. These precautions are used for contact with blood; all body fluids, secretions, and excretions except sweat (regardless of whether these fluids, secretions, or excretions contain visible blood); non-intact skin; and mucous membranes. Barrier techniques are designed to decrease exposure of health care personnel to body fluids containing human immunodeficiency virus or other blood-borne pathogens. Precautions are used at all times because medical history and examination cannot reliably identify all patients infected with these agents. Standard precautions decrease transmission of microorganisms from patients who are not recognized as harbouring potential pathogens, such as antimicrobial-resistant bacteria. Standard precautions include the following techniques:

- hand hygiene
- gloves
- masks, eye protection, and face shields
- non-sterile gowns
- proper handling of patient care equipment, used linen, mouthpieces, resuscitation bags, and other ventilation devices
- proper cleaning and disposition of needles, scalpels, and other sharp instruments and devices.

# Table of Contents

<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Preface</td>
<td>xiii</td>
</tr>
<tr>
<td>ACoRN Overview</td>
<td>xv</td>
</tr>
<tr>
<td>What is ACoRN? What are the objectives of the ACoRN Program?</td>
<td>xv</td>
</tr>
<tr>
<td>What is the ACoRN Textbook?</td>
<td>xv</td>
</tr>
<tr>
<td>What is the ACoRN Workshop?</td>
<td>xvi</td>
</tr>
</tbody>
</table>

## Chapter 1 The ACoRN Process

- Objectives                                      | 1-1  |
- Key Concepts                                    | 1-2  |
- The ACoRN Framework                             | 1-3  |
- The ACoRN Process                               | 1-5  |
- Illustrative Case Study                         | 1-12 |
- Summary                                        | 1-14 |
- Sequences
  - Resuscitation                                  | 1-15 |
  - Respiratory                                    | 1-16 |
  - Cardiovascular                                 | 1-17 |
  - Neurology                                      | 1-18 |
  - Surgical Conditions                            | 1-19 |
  - Fluid & Glucose Management                     | 1-20 |
  - Thermoregulation                               | 1-21 |
  - Infection                                      | 1-22 |

## Chapter 2 Resuscitation

- Objectives                                      | 2-1  |
- Key Concepts and Skills                         | 2-2  |
- Introduction                                    | 2-3  |
- Resuscitation Signs                             | 2-3  |
  - Ineffective breathing                          | 2-3  |
  - Heart rate < 100 bpm                           | 2-3  |
  - Central cyanosis                               | 2-4  |
- The Resuscitation Sequence                      | 2-5  |
- Core Steps, Organization of Care, Response, and Next Steps | 2-4  |
- Case 1 – Apnea during feeding                    | 2-10 |
- Case 2 – Apneic episodes in a preterm baby      | 2-13 |
- Answers to Questions                            | 2-16 |
- Bibliography                                    | 2-16 |

## Chapter 3 Respiratory

- Objectives                                      | 3-1  |
- Key Concepts and Skills                         | 3-2  |
- Introduction                                    | 3-3  |
### Alerting Signs

- Labored respiration
- Respiratory rate > 60/min
- Receiving respiratory support

### The Respiratory Sequence

### Core Steps, Organization of Care, Response, Next Steps, and Specific Management

### The Respiratory Score

<table>
<thead>
<tr>
<th>Respiratory Distress Syndrome</th>
<th>3-13</th>
</tr>
</thead>
<tbody>
<tr>
<td>Meconium aspiration syndrome</td>
<td>3-16</td>
</tr>
<tr>
<td>Pneumothorax</td>
<td>3-17</td>
</tr>
<tr>
<td>Pneumonia</td>
<td>3-21</td>
</tr>
<tr>
<td>Persistent pulmonary hypertension of the newborn</td>
<td>3-22</td>
</tr>
<tr>
<td>Lung hypoplasia</td>
<td>3-23</td>
</tr>
<tr>
<td>Case 1 – Mild respiratory distress in a term newborn</td>
<td>3-25</td>
</tr>
<tr>
<td>Case 2 – Respiratory distress in a preterm newborn, initiating CPAP</td>
<td>3-35</td>
</tr>
<tr>
<td>Case 3 – Respiratory distress in a preterm newborn, initiating mechanical ventilation</td>
<td>3-44</td>
</tr>
<tr>
<td>Case 4 – Sudden deterioration in a ventilated baby</td>
<td>3-53</td>
</tr>
<tr>
<td>Case 5 – Meconium aspiration</td>
<td>3-62</td>
</tr>
</tbody>
</table>

### Case 1 – The baby presenting with shock

### Case 2 – Baby with persistent cyanosis

### Case 3 – Baby with supraventricular tachycardia

### Answers to Questions

### Bibliography

### Chapter 4 Cardiovascular

<table>
<thead>
<tr>
<th>Objectives</th>
<th>4-1</th>
</tr>
</thead>
<tbody>
<tr>
<td>Key Concepts and Skills</td>
<td>4-2</td>
</tr>
<tr>
<td>Introduction</td>
<td>4-3</td>
</tr>
</tbody>
</table>

#### Alerting Signs

- Pale, mottled or grey
- Weak pulses or low blood pressure
- Cyanosis unresponsive to oxygen therapy
- Heart rate > 220 bpm

#### The Cardiovascular Sequence

### Core Steps, Organization of Care, Response, Next Steps, and Specific Management

<table>
<thead>
<tr>
<th>Case 1 – The baby presenting with shock</th>
<th>4-16</th>
</tr>
</thead>
<tbody>
<tr>
<td>Case 2 – Baby with persistent cyanosis</td>
<td>4-26</td>
</tr>
<tr>
<td>Case 3 – Baby with supraventricular tachycardia</td>
<td>4-37</td>
</tr>
</tbody>
</table>

### Answers to Questions

### Bibliography

### Chapter 5 Neurology

<table>
<thead>
<tr>
<th>Objectives</th>
<th>5-1</th>
</tr>
</thead>
<tbody>
<tr>
<td>Key Concepts and Skills</td>
<td>5-2</td>
</tr>
<tr>
<td>Introduction</td>
<td>5-3</td>
</tr>
</tbody>
</table>

#### Alerting Signs

- Abnormal tone
- Jitteriness
- Seizures

#### The Neurology Sequence

### Core Steps, Organization of Care, Response, Next Steps, and Specific Management

<table>
<thead>
<tr>
<th>Case 1 – The floppy baby</th>
<th>5-11</th>
</tr>
</thead>
<tbody>
<tr>
<td>Case 2 – A 6-hour old baby with seizures</td>
<td>5-21</td>
</tr>
<tr>
<td>Case 3 – Baby born to a substance-using mother</td>
<td>5-32</td>
</tr>
</tbody>
</table>

### Answers to Questions

### Bibliography

viii ACoRN
Chapter 6 Surgical Conditions
Objectives 6-1
Key Concepts and Skills 6-2
Introduction 6-3
Alerting Signs
- Anterior abdominal wall defect 6-3
- Vomiting or inability to swallow 6-3
- Abdominal distension 6-4
- Delayed passage of meconium or imperforate anus 6-4
The Surgical Conditions Sequence 6-5
Core Steps, Organization of Care, Response, Next Steps, and Specific Management 6-6
Case 1 – Abdominal wall defect 6-12
Case 2 – Inability to pass a nasogastric tube 6-18
Bibliography 6-23

Chapter 7 Fluid & Glucose Management
Objectives 7-1
Key Concepts and Skills 7-2
Introduction 7-3
Alerting Signs
- Blood glucose < 2.6 mmol/L 7-6
- At risk for hypoglycemia 7-6
- Not feeding or should not be fed 7-8
The Fluid & Glucose Management Sequence 7-7
Core Steps, Organization of Care, Response, Next Steps, and Specific Management 7-8
Case 1 – Infant of a diabetic mother 7-16
Case 2 – Symptomatic hypoglycemia 7-24
Answers to Questions 7-30
Bibliography 7-31

Chapter 8 Thermoregulation
Objectives 8-1
Key Concepts 8-2
Introduction 8-3
Alerting Signs
- Axillary temperature < 36.3°C or > 37.2°C 8-3
- Increased risk for temperature instability 8-3
The Thermoregulation Sequence 8-5
Core Steps, Organization of Care, Response, Next Steps, and Specific Management 8-6
Case 1 – The cold, outborn baby 8-11
Case 2 – A baby with hyperthermia 8-19
Answers to Questions 8-24
Bibliography 8-24

Chapter 9 Infection
Objectives 9-1
Key Concepts and Skills 9-2
Introduction 9-3
Alerting Signs
- Risk factors for infection 9-3
ACoRN alerting signs with an asterisk (*) & Clinical deterioration 9-3
The Infection Sequence 9-4
Core Steps, Organization of Care, Response, Next Steps, and Specific Management 9-4
Case 1 – Baby with respiratory distress and prolonged rupture of membranes 9-10
Answers to Questions 9-19
Bibliography 9-20

**Chapter 10 Transport**
Objectives 10-1
Key Concepts 10-2
Introduction 10-3
The Transport Process 10-4
Sample Neonatal Pre-transport Information Sheet 10-5
Responsibilities of:
The sending facility 10-6
The transport clinical coordinator 10-7
The receiving physician 10-8
The transport team 10-8
Shared responsibilities 10-9
Communicating with the family 10-9
Bibliography 10-10

**Chapter 11 Support**
Objectives 11-1
Key Concepts 11-2
Introduction 11-3
Supporting the Baby 11-4
Stability and stress responses 11-4
Developmentally supportive care 11-6
Illustrative Case Study 11-7
Assessment and management of pain 11-8
Supporting the Family 11-10
Supporting the Health Care Team 11-11
Palliative Care 11-13
Answers to Questions 11-15
Bibliography 11-16

**Appendix A Neonatal assessment**
Sample neonatal assessment tool A-3

**Appendix B Review of Neonatal Resuscitation Skills**
Free-flow oxygen administration during resuscitation B-3
Manual ventilation B-4
Endotracheal intubation B-6
Exhaled CO₂ detectors – for endotracheal tube placement B-9
Laryngeal mask airway B-11
Chest compressions B-13
Emergency vascular access: Umbilical vein catheterization B-14
Emergency vascular access: Intraosseous vascular access B-16
Epinephrine B-19
## Table of Contents

**Volume expander**  
**Sodium bicarbonate**

### Appendix C Procedures
- Blood pressure measurement
- Blood sampling, capillary
- Bowel bag application
- Cardiorespiratory monitoring
- Continuous positive airway pressure (CPAP)
- Mechanical ventilation
- Pneumothorax, chest transillumination
- Pneumothorax, chest tube insertion
- Pneumothorax, needle aspiration
- Pulse oximetry

### Appendix D Investigations (interpretation)
- Blood gases
- Complete blood count (CBC) and differential count
- Chest radiographs

### Appendix E Medications
- Ampicillin
- Cefotaxime
- Cloxacillin
- Dopamine
- Fentanyl
- Gentamicin
- Morphine
- Penicillin G
- Phenobarbital
- Phenytoin
- Premedication for intubation
- Prostaglandin E₁ (PGE₁)
- Surfactant
- Vancomycin

### Appendix F Initiating Therapeutic Hypothermia for Hypoxic Ischemic Encephalopathy
- Initiating Therapeutic Hypothermia or Therapeutic Normothermia
- Using Cool Gel Pack for the Initiation of Therapeutic Hypothermia

### Index

---

**Sequences**
- The ACoRN Framework
- The ACoRN Process
- The ACoRN Primary Survey
- The ACoRN Problem List
- The ACoRN Sequence design
- The Resuscitation Sequence
- The Respiratory Sequence
- The Cardiovascular Sequence
The Neurology Sequence 1-18
The Surgical Conditions Sequence 1-19
The Fluid & Glucose Management Sequence 1-20
The Thermoregulation Sequence 1-21
The Infection Sequence 1-22

Tables
- Target preductal pulse oximetry values after birth 2-7
- The Respiratory Score 3-7
- Clinical assessment of circulation 4-8
- Tolerance to different levels of SpO2 4-35
- Key features of sinus tachycardia, supraventricular tachycardia and atrial flutter 4-45
- Jitteriness vs seizures 5-4
- Clinical assessment of neurological dysfunction 5-9
- Baseline fluid intake (oral and intravenous) for the first few days of life 7-4
- Suggested steps for increasing glucose intake for the treatment of hypoglycemia 7-15
- The amount of glucose provided by milk and intravenous dextrose 7-22
- Initial incubator temperature settings in the first 12 hours of life 8-9
- Strategies for preventing heat loss 8-14
- Common organisms causing neonatal sepsis (early and late onset) 9-16
- Choosing initial antibiotics 9-17
- Stability cues and stress cues 11-5
- Morphine and fentanyl 11-9
- Endotracheal tube size B-7

Sample Forms
- Contact Form for Newborn Resuscitation and Stabilization 2-11
- Seizure log 5-31
- Neonatal abstinence score 5-36
- Neonatal Pre-Transport Information Sheet 10-5
- Template for case review 11-12
- Neonatal Assessment Tool A-3

Radiographs
- Transient tachypnea of the newborn 3-12
- Respiratory distress syndrome 3-13
- Meconium aspiration syndrome 3-16
- Pneumothorax 3-17
- Pneumomediastinum 3-20
- Pneumonia 3-21
- Congenital diaphragmatic hernia 3-23
- Normal chest radiograph 4-13
- Transposition of the great arteries 4-13
- Patent ductus arteriosus 4-14
- Duodenal atresia 6-9
- Ileal atresia 6-10
- Esophageal atresia/tracheo-esophageal fistula 6-21
- Correct/incorrect endotracheal tube placement B-9
- Umbilical venous catheter in portal system (incorrect placement) B-16
- Chest radiograph interpretation D-9