Principles of anaesthesia for term neonates: an updated practical guide

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Abstract

Term neonates present for various surgical procedures, many of which are urgent and are probably best cared for in specialised paediatric centres where expertise is concentrated. Pathophysiological derangements caused by the underlying condition, associated congenital anomalies and immaturity of key physiological and metabolic processes all contribute to make anaesthesia especially challenging in the neonate. For these reasons, anaesthesia-associated morbidity and mortality is greater in this group than in older infants and children. Meticulous attention to all aspects of perioperative care is vital to ensure the best possible outcome. The principles of safe practice of anaesthesia for term neonates are outlined in this article, which excludes neonatal cardiac surgery and the details of neonatal pain management. Finally, the potentially deleterious effects of general anaesthetics on the developing brain are discussed.

Keywords Anaesthesia; infant; neonate; neurotoxicity; paediatric; term

Royal College of Anaesthetists CPD matrix: 2A03, 2D02, 2D04, 3D00

Learning objectives

After reading this article, you should be able to:

- list procedures for which neonates typically present for surgery
- outline the necessary steps and equipment required to safely and efficiently anaesthetise a term neonate for surgery
- summarise current understanding on anaesthetic neurotoxicity and recommendations for use of anaesthetics in neonates and infants.

Definition

By definition, a term infant is born between 37 and 42 weeks' gestation. The gestational age is calculated as the interval between the first day of the mother's last menstrual period and birth. Ultrasonographic measurement of in utero fetal crown—rump length during the first trimester provides a more accurate estimate. The neonatal period is defined as the first 28 days of life whatever the gestational age.

Inpatient or day surgery?

Common neonatal surgical conditions are listed in Table 1. Most neonatal surgery is undertaken on an urgent basis with patients coming directly from the neonatal intensive care unit (NICU), to where they return. Concerns over the likely extent and duration of postoperative apnoea have dictated overnight hospital stays for otherwise healthy term neonates. However, finite resources have driven an increasing trend toward outpatient surgery and stimulated interest in the suitability of this approach for neonates. There is surprisingly little available evidence to inform this practice. A study of pyloromyotomy surgery in term babies quantified the risk of postoperative apnoea as 16%.[1] It is anticipated that the General Anesthesia Study (GAS, trial registration NCT00756600) will provide more data on the frequency of apnoea in the immediate postoperative period.

The type, duration and complexity of the surgery, as well as any associated physiological derangement and expected requirement for postoperative analgesia, all influence the need for admission. Current evidence suggests that healthy term neonates who undergo uneventful surgery (not requiring opioid analgesia) may be allowed to go home after an indeterminate period of postoperative monitoring. Currently, individual centres develop their own guidelines, e.g. minimum gestational age in term infants of 44 weeks plus 4 hours of uneventful postoperative observation.

Location

Neonatal surgery should ideally proceed only where trained personnel, infrastructure and processes are in place to ensure safe optimal practice. Prenatal screening and diagnosis (e.g. gastroschisis) has resulted in increased referral for planned delivery at specialist centres, where early corrective surgery can proceed without delay.

Preoperative evaluation

Antenatal and birth history

Obtain a thorough perinatal history, including gestational age, intrauterine problems, mode of delivery, Apgar scores and any requirement for cardiopulmonary resuscitation. Further inquiry should elicit other early postnatal problems requiring attention (e.g. hypoglycaemia, sepsis). Congenital anomalies must be excluded, for example cardiac lesions are present in 30% of neonates with exomphalos. The anaesthetic implications of an unfamiliar syndrome should be determined; a good online resource is the OMIM (Online Mendelian Inheritance in Man) at omim.org.

A baseline haemoglobin measurement should be obtained and blood samples from mother and neonate tested for ABO/Rh (D) incompatibility. Transfusion thresholds are typically higher (12 g/dl) in neonates than in older infants (anaemia is a risk factor for apnoea). Ensure vitamin K was given at delivery to protect against haemorrhagic disease of the newborn.

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Common neonatal surgical conditions

Surgical specialty	Procedures/conditions
General surgery	• Tracheo-oesophageal fistula • Congenital diaphragmatic hernia • Gastroschisis/exomphalos • Pyloromyotomy • Laparotomy (e.g. atresia/malrotation/ Hirschsprung) • Central venous access • Inguinal hernia repair • Imperforate anus
Neurosurgery	• Myelomeningocoele • Encephalocoele • Ventriculoperitoneal shunt
Plastic surgery	• Cleft lip/palate
Eye surgery	• Examination under anaesthesia • Laser treatment • Congenital cataract
Radiology	• Diagnostic cardiac catheter • Interventional cardiac catheter (e.g. atrial septostomy) • Other radiological interventions (i.e. MRI)
Urological surgery	• Posterior urethral valve excision • Cystoscopy

Table 1

Assessment at the preoperative visit

Factor	Check
Airway	Oro/nasopharyngeal airway, endotracheal tube size, length, cuff. Intubation details/ difficulties. Suctioning requirements
Breathing	Recent arterial blood gas/chest radiograph, inspired oxygen/nitric oxide, ventilator settings (mode, inspiratory/positive end-expiratory pressures, rate), chest drains
Circulation	Intravascular access, pulse rate, blood pressure, central venous pressure (plus trends). Capillary refill time, urine output, inotrope requirements
Disability	Wakefulness, sedation, paralysis. Neurological deficits
Exposure	Core temperature, core—peripheral difference
Fluids/infusions	Maintenance fluids/requirements. Blood/ clotting products available (capillary samples overestimate haemoglobin). Stoma/ nasogastric tube output
Glucose	Recent blood glucose. Total parenteral nutrition/10% dextrose/insulin infusion rates
Weight	Drug dose calculations

Table 2

Current status

A systematic approach to preoperative assessment prevents missing significant problems (Table 2).

Appropriate fasting times for elective procedures are 2 hours for clear liquids, 4 hours for breast milk, 6 hours for formula/ non-human milk.[2] Prolonged fasting risks dehydration and hypoglycaemia, so dextrose-containing intravenous maintenance fluids (typically 10%) should be instituted early.

The anaesthetic plan, including regional techniques, blood transfusion and use of rectal suppositories should be explained to the parent/guardian, and consent obtained. Similarly, post-operative expectations and disposition (e.g. intravascular lines, analgesia plans and likely need for elective postoperative ventilation) should be discussed at this time.

Preparation of the operating theatre

Temperature: neonates lose heat rapidly due to an increased surface area to volume ratio, skin conductance (little subcutaneous fat) and evaporative heat loss (reduced skin keratin content), and are reliant on non-shivering thermogenesis (brown fat metabolism). The operating theatre should be maintained at 30—32 °C, the neonate's thermoneutral temperature. Commonly used devices include a forced-air warming mattress, overhead radiant heater, warmed blankets and clear plastic drapes.

Fluids: fluid requirements exceeding maintenance and all blood products should routinely be warmed. Our practice is to attach a distal three-way stopcock to the fluid warmer to allow warmed fluid boluses to be dispensed accurately. Maintenance fluids are simply continued from the NICU via an infusion pump, or titrated using a burette.

Positioning: requires meticulous, ongoing attention. Safe, reliable support of both baby and equipment is achieved with a combination of tape, soft foam padding and rolls. A metal 'U' bar attached firmly to the operating table and positioned above the head allows unrestricted access to the draped baby, provides protection from errant surgeons' elbows and prevents kinking or occlusion of the breathing circuit.

Equipment

Airway: a selection of appropriately sized face masks, endotracheal tubes (ETT), oropharyngeal airways, straight and curved laryngoscope blades, stylets and suction catheters should be immediately available. There is an increasing number of advanced airway devices allowing indirect visualisation of the larynx (Glidescope, AirTraq) that are advocated for the difficult paediatric airway. However, data comparing such devices are currently lacking, and their use depends on anaesthetist preference and expertise.[3] An appropriately sized laryngeal mask airway (LMA) may be considered for select infants undergoing certain procedures, although many paediatric anaesthetists consider the smaller sized LMAs to provide unreliable airway control.[4]

Ventilation: an infant-compatible ventilator, capable of delivering small tidal volumes (usually in pressure-controlled mode) and positive end-expiratory pressure is essential. The Jackson—Rees modification of Ayre's T-piece is the most frequently used breathing attachment in the UK, although circle system use is

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