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Title: Anesthesia for pediatrics and geriatrics

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Pediatric anesthesia

Definitions:

Neonate = less than 28 days old.

Infant = 28 days to 1 year old.

Child = 1 year to 16 years old (dependent on local laws of consent).

Anatomical differences of pediatrics than the adults:

1) Larger head, shorter neck and larger tongue.
2) Glottic inlet is higher, epiglottis is longer and curved.
3) The narrowest part of the larynx is the cricoid ring.
4) Ribs are more horizontal and breathing is diaphragmatic rather than intercostals.

Physiological differences in pediatrics than the adults:

1) Functional residual volume (FRC) lies close to the closing volume (CV) in the infants and the reduction in FRC with anesthesia or disease can lead to atelectasia and segmental collapse unless positive end-expiratory pressure (PEEP) is applied.
2) In infants, alveolar ventilation and oxygen demand are much higher than in the adults, but the FRC/V_A (alveolar ventilation) is much lower (half), so the reserves of oxygen in the lung of the infant are lower.
3) Unlike in adults, mild hypoxia in the neonate causes hypoventilation leading to apnea.
4) Basal metabolic rate, caloric requirements and O_2 uptake is are higher.
5) Glycogen stores are relatively low, but brain and myocardium are more glucose

dependent.

6) Cardiac output average (relative to body weight) and heart rate are greater.
7) The neonate has limited responses to cold (vasoconstriction rather than shivering) and there is an increased propensity to bradycardia.
8) In general, infants have larger volumes of distribution for most drugs, and even susceptible infants may require larger initial doses of drugs to achieve adequate plasma concentrations.

Normal respiratory rate and heart rate according to age

Age group	Heart rate Beat/ min	Respiratory rate Breath/ min
Less than 1 year	110 - 160	30 – 60
1 to 3 years	100 - 150	24 – 40
3 to 6 years	95 - 140	22 – 34
6 to 12 years	80 - 120	18 – 30
12 to 18 years	60 - 100	12 – 16

Practical conducts for general anesthesia

Fasting guidelines: Neonates and pre-weaned infants will become irritable, dehydrated and hypoglycemic if starved for extended periods. For elective surgery a widely used scheme is:

a) Solids- morning case, no solid food overnight; afternoon case, light food at breakfast; no solid food for 6 hours before surgery.

b) Milk- up to 4 hours before surgery for bottled milk, up to 3 hours before surgery for breast milk.

c) Clear liquids- up to 2 hours before surgery.

Children with major organ dysfunctions, or those actually ill with infection or trauma, should be treated as though they had a full stomach regardless of fasting interval because these conditions are associated with delayed gastric emptying. Small infants

should be scheduled first on an operating list to improve planning, but it may still be necessary to commence intravenous fluids.

Premedication:

- local anesthetic creams prior to venipuncture has reduced the necessity for sedative premedication.
- Occasionally, a sedative drug required, this is particularly useful for child who, in spite of good preoperative preparation, remains apprehensive. Currently, oral midazolam is a widespread popular,
- an alternative to midazolam is oral ketamine, in that case, an antisialagogue (e.g. atropine) should beadded to prevent excess salivation.
- If profound degrees of sedation are required, it is possible to combine midazolam and ketamine. The incidences of nausea and vomiting and of excess sedation in the postoperative period are increased.
- Intramuscular premedication is generally not tolerated well by children.
- Rectal administration of induction agents has been used (such as thiopental), this form of premedication may be used only under the direct supervision of the anesthetist, as respiratory depression is a distinct possibility.

Induction of anesthesia:

- Unlike adult practice, it is not possible to have all the necessary monitoring devices placed on the child before induction. In most cases, if should be possible to place an appropriately sized pulse oximeter probe on a digit. Most children also allow the placement of precordial stethoscope.

- The appropriate monitoring should be placed as soon as possible after the start ofanesthesia.

- When inhalational induction is planned, clear scented plastic masks are much more acceptable to little children. Clear masks allow respiration and thepresence of vomitus to be observed.

Gas induction has become increasingly preferred since the introduction of sevoflurane. It is usually elected from the outset together with nitrous oxide and oxygen.

- intravenous induction depends on child's preference, suitability of veins, technical expertise and state of the child. Doses should be titrated to effect: neonates and sick infants may require reduced dose, whereas 3–5-year-old need relatively larger doses than adults (e.g., required propofol dose is 2.5-5mg/ kg while it is in adults 1-2.5 mg/ kg). The pain on induction with propofol can be reduced by adding 20 mg lidocaine to 200 mg propofol. Thiopental provides a smooth induction but can delay postoperative recovery.

Maintenance:

- Most simple short procedures require only spontaneous ventilation under a volatile or intravenous anesthetic agent and analgesia that will extend into the postoperativeperiod.

- Neonates are usually intubated and ventilated for surgical procedures to ensure adequate gas exchange, and are given local anesthetic blockade where possible to limit CNS depressant drug usage.

- In complex procedures where postoperative ventilation is planned, high-dose opioid techniques are often used to minimize stress responses.

Regional analgesia:

Regional blocks reduce intraoperative anesthesia requirements and provide a postoperative analgesia and, unlike systemic analgesia, may provide complete analgesia without systemic side-effects.

I.V fluids:

Crystalloids:

- Intraoperative hypoglycemia can occur in neonates, but is unusual owing to the effects of the stress response on glycolysis and gluconeogenesis.
- In contrast, excessive perioperative administration of glucose solutions can lead to hyponatremia,water intoxication and cerebral edema.
- Hartmann's solution (Ringer's lactate solution) can be given as a sole agent during surgery,
- it is wise to measure blood glucose hourly during prolonged cases, alternatively, a fixed maintenance infusion of a glucose-containing solution should be continued throughout, with additional fluid replacement of Hartmann's given independently.
- A recognized formula formaintenance fluid hourly rates is:

  HOLLIDAY – SEGAR FORMULA

  1-10 kg = 4 ml/ kg
  11-20 kg = 40 + 2 ml/ kg
  over 20 kg = 60 + 1 ml/ kg

- It has been shown that a mixture of glucose 2.5% in Ringer's lactate can maintainnormal glucose while avoiding hyponatremia.
- Increased replacement fluids may be required if the gut remain exposed.

Colloids and blood:

- The threshold for transfusion will vary the child's overall condition and associated pathologies. For otherwise healthy children it is acceptable to let Hb drop to 8-9 g/dl,
- neonates and children with cardiac or pulmonary conditions may benefit from a Hb raised to 10-13 g/dl.
- A volume formula for transfusion is:

  (Hb required – Hb actual) × (body weight in kg) × 5 = volume of red cells required(using resuspended SAGM blood).

- Fresh frozen plasma and platelets may need replacing earlier than in adults

to prevent coagulopathy.

- These colloids contain citrate and will require additional calcium administration to prevent significant hypocalcemia if infused quickly.

Endotracheal tubes:

For children over 1 year:

- Appropriate tube internal diameter (ID) can be approximately estimated by the formula: age / 4 + 4.
- Appropriate tube length in cm. can be approximately estimated by the formula: age / 2 + 12 oral (+15 for nasal).

In infants:

- Appropriate tube ID sizes for preterm: <1500 g = 2.5 mm, 1500-3000 g = 3 mm, over 3000 g = 3.5 mm.
- Oral length in cm. is given by the formula (6 + weight in kg).

Laryngeal mask airway (LMA):

- They are useful in short procedures with spontaneous ventilation.
- They have less resistance than endotracheal tubes
- of considerable use for insertion of fiber-optic bronchoscopes.

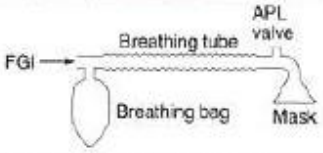
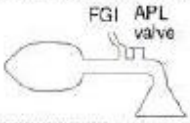
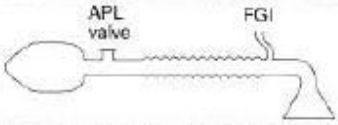
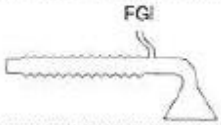
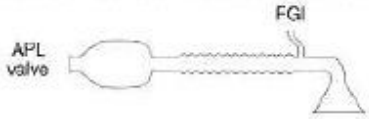
Approximate sizes are:

- 1 for less than 6.5 kg.
- 2 for 6.5-20 kg.
- 2.5 for 20-30 kg.
- 3 for 30 kg and above.

A size 1.5 is also available. The armored versions have reduced risk of kinking and are longer and narrower. The use of the size 1 has not been widespread because of concerns about secure insertion, increased dead space and atelectasis. Although it has been used in neonatal resuscitation, it is not yet recommended for controlled ventilation in small children because of the risk of ventilator impairment from gastric distension.

Breathing systems:

Table 3–2. Classification and characteristics of Mapleson circuits.

Mapleson Class	Other Names	Configuration[1]	Required Fresh Gas Flows: Spontaneous	Required Fresh Gas Flows: Controlled	Comments
A	Magill attachment		Equal to minute ventilation (≈ 80 mL/kg/min)	Very high and difficult to predict	Poor choice during controlled ventilation. Enclosed Magill system is a modification that improves efficiency. Coaxial Mapleson A (Lack breathing system) provides waste-gas scavenging.
B			2 × minute ventilation	2–2½ × minute ventilation	
C	Waters' to-and-fro		2 × minute ventilation	2–2½ × minute ventilation	
D	Bain circuit		2–3 × minute ventilation	1–2 × minute ventilation	Bain coaxial modification: fresh gas tube inside breathing tube (see Figure 3–7).
E	Ayre's T-piece		2–3 × minute ventilation	3 × minute ventilation (I:E = 1:2)	Exhalation tubing should provide a larger volume than tidal volume to prevent rebreathing. Scavenging is difficult.
F	Jackson-Rees' modification		2–3 × minute ventilation	2 × minute ventilation	A Mapleson E with a breathing bag connected to the end of the breathing tube to allow controlled ventilation and scavenging.

[1]FGI, fresh gas inlet; APL, adjustable pressure limiting (valve).

- Common breathing systems used in pediatric practice include Ayre's T-piece(Mapleson E), Jackson-Rees modification (Mapleson F), Bain systems and circle.
- The Mapleson F system remains the mainstay of pediatric anesthesia. It is compactand light, with low dead space and airway resistance. It can function in spontaneousand controlled ventilation with or without manual continuous positive airway pressure(CPAP).
- The Bain system behaves like a Mapleson E or F circuit and has been used in all age groups.
- The circle system is has become preferred for controlled ventilation in pediatrics because of heat and moisture conversation as well as cost efficiencies.

Geriatric anesthesia

People above 65 years are defined as old ages, Ageing is characterized by degenerative changes in structure and function of organs and tissues, there is

- gradual loss of skeletal tissue mass,
- increase in body fat,
- reduction in total body water,
- reduce in albumin levels.
- Decreased skin elasticity increases the risk of injury from the use of various adhesive tapes.
- Adding a thin layer of cotton batting wrap before applying the noninvasive blood pressure cuff may be a simple but effective maneuver for the prevention of neurovascular complication.
- Thinner layer of subcutaneous fat, which predisposes elderly patients to the potential for pressure sores. Protecting elderly patient's bony prominences, padding with pillows and arm-support devices should be ensured.

Drugs:

Old aged patients are very sensitive to anesthetic agents.

- Lower concentration of drug is required to achieve a desired effect and effect is usually prolonged.
- Gradual titration of drug to dosage effect is usually required, boluses must alwaysbe avoided.
- One must be cautious of hemodynamic surges.
- Intravenous drugs may have longer circulation time and delayed onset of effect.
- Elderly patients display a lower dose requirement for propofol, etomidate, barbiturates, opioids, and benzodiazepines.

- Administration of a given volume of epidural local anesthetictends to result in more extensive spread in elderly patients.
- A longer duration of action should be expected from a spinal anesthetic.
- Prolonged circulation time delays the onset of intravenous drugs, but speeds induction with inhalational agents.
- Elderly requires lesser dosage of opioid agents. Sufentanyl, fentanyl and alfentanil are twice potent in elderly as compared to adult population owing to altered sensitivity of brain to opioids. As the central compartment is reduced in geriatrics infusion rates should be reduced and titrated to effect.
- Metabolism of neuromuscular blockade agents (skeletal muscle relaxants) whichdepend on liver and renal blood flow is reduced, thereby prolonging the duration of effect. Metabolism of atracurium and cis-atracurium is unaffected by age, as they are metabolized by Hoffman degradation (spontaneous degradation in plasma and tissue at normal body PH and temperature).
- Aging is associated with a decreasing response to β-adrenergic agents (e.g., adrenaline, dobutamine).

Airway management:

- They have limited neck mobility, because of arthritic changes.
- They have difficult mask ventilation due to the absence of multiple teeth. Goal of pre-oxygenation maynot be reached because of that.
- They are tending to sleep apnea due to reduction in upper airway consistency that placing them at increased risk of pulmonary complications.
- Intubation should be rapid, gentle and atraumatic.

Notable benefits of regional anesthesia in old age:

1) Decreased incidence of deep venous thrombosis.
2) Blood flow improved.
3) Provide adequate pain relief.
4) Maintain spontaneous airway.

5) Pulmonary functions are intact depending on the level of blockade.

Other physiological notes about old age:

1) Increased vagal tone and decreased sensitivity of adrenergic receptors lead to a decrease in heart rate.
2) Decreased elasticity of lung tissue, allowing over distention of alveoli and collapse of small airways. Residual volume and the functional residual capacity increased. Airway collapse increases residual volume and closing capacity.
3) Impairment of Na+ handling, concentrating ability, and diluting capacity predispose elderly patients to both dehydration and fluid overload.
4) Liver mass and hepatic blood flow reduced with aging. Hepatic function declines in proportion to the decrease in liver mass.
5) Aging produces both pharmacokinetic and pharmacodynamic changes.

MCQ TEST

1- The benefits of regional anesthesia in elderly (all true except one)
   a) Maintain spontaneous airway.
   b) Risk of deep venous thrombosis.
   c) Good pain relief postoperatively.
   d) Improves blood flow.
   e) No side effects of intubation.
2- Endotracheal intubation in pediatrics (all true except one)
   a) internal diameter (ID) can be approximately estimated by the formula: age / 4 + 4.
   b) tube length in cm. can be approximately estimated by the formula: age / 2 + 12 for oral tube.
   c) For 4th. Month baby, the endotracheal tube ID=6mm.
   d) For preterm infant=2.5mm
   e) Infants need smaller endotracheal tube than child
3- Airway management in geriatric (which one is true)

a) limited neck mobility because of obesity.
b) difficult mask ventilation due to arthritic joint.
c) Increased elasticity of lung tissue leading to over distention of alveoli
d) Residual volume and the functional residual capacity increased.
e) Loss of teeth have no role in difficult intubation.

4- Aging is associated with all the following except one
a) decreased sensitivity of adrenergic receptors lead to a decrease in heart rate.
b) Metabolism of atracurium and cis-atracurium is unaffected by age.
c) Old aged patients are very sensitive to anesthetic agents.
d) Elderly requires larger dosage of opioid agents
e) speeds induction with inhalational agents.

5- Which of the following system is the mainstay of pediatric anesthesia
a) The Mapleson F system.
b) The Mapleson D system
c) The Mapleson A system
d) The Mapleson B system
e) The Mapleson E system

6- Approximate sizes for Laryngeal mask airway in pediatrics (all true except one)
a) 1 for less than 6.5 kg.
b) 2 for 6.5-20 kg.
c) 2.5 for 20-30 kg.
d) 3 for 30 kg and above
e) 4 for 30 kg and below.

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GOOD LUCK

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