Anaestheasier
making anaesthesia easier

# All the equations we think you need for the FRCA

*If there are any missing, let us know and we'll add them!*

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## Pharmacokinetics and pharmacology

**Plasma concentration**

- Concentration = Dose/Volume of distribution
- Loading dose = volume of distribution x desired concentration
- Infusion rate = desired concentration x clearance

**Rate of elimination and half life**

- Rate of elimination = Css x clearance
- Half life = 0.693 x Volume of distribution/Clearance
- Half life = 0.693/Ke
- $\tau$ =1/Ke
- $\tau$ =Vd/Cl
- Ke = Clearance/Vd

Css = *steady state concentration*

*Ke = elimination rate constant*

Explanation here

**Clearance**

- Clearance = Ke x Volume of distribution
- Clearance = Urine concentration x urinary flow/plasma concentration
- Clearance = Dose/AUC

**Caudal block dose**

- Lumbosacral block - 0.5 ml/kg
- Thoracolumbar block - 1 ml/kg

- Midthoracic block - 1.25 ml/kg

*This is for 0.25% bupivacaine.*

**Steroid equivalence**

The following are all equivalent doses

- Methylprednisolone - 4mg
- Prednisolone - 5mg
- Hydrocortisone - 20mg
- Cortisone - 25 mg

# Physics

**Ohm's law**

- Volts = Current x Resistance

**Power, charge and energy**

- Charge = Voltage x capacitance
- Power = Current x Voltage
- Power = Energy/Time
- Volts = Energy/Charge
- Energy = Charge x voltage/2
- Energy = (Capacitance x voltage^2) /2
- Energy = Mass x specific heat capacity x temperature

**Resistance**

For a series circuit

- Total resistance = R1 + R2 + ... + Rn

For a parallel circuit

- 1/Total resistance = 1/R1 + 1/R2 + ... + 1/Rn

**Force, energy and pressure**

- Energy = Force x distance
- Energy = pressure x volume
- Force = mass x acceleration
- Kinetic energy = 0.5 x mass x velocity^2
- Potential energy = mass x gravitational acceleration x height

**Hagen Pouiselle**

- Q = πΔPr4/8ηl

Q = Flow, *ΔP - change in pressure, η - viscosity, l - length of tube*

**Turbulent flow**

Re = pvD/η

*p - density, D - diameter of tube, η - viscosity*

*Turbulent flow is more affected by density*

*Laminar flow is more affected by viscosity*

**Doppler equation**

- Fd= 2FtVCos θ / C

*Ft -transmitted Doppler frequency, V i- speed of blood flow, Cos θ - Cosine of the blood flow to beam angle, C - speed of sound in tissue*

**Pressure equivalence**

The following are all the same:

- 101 kPa
- 1 atm
- 760 mmHg
- 1033 cmH2O
- 101 325 N/M^2
- 101 325 Dynes/cm^2
- 14.4 PSI

**Gas laws**

Universal gas law

- PV = nRT

Boyle's law

- V1P1 = V2P2 at a given temperature

Charles' law

- V is proportional to T for a given pressure

Gay-Lussac's law

- P is proportional to T for any given volume

Dalton's law

- Total pressure = sum of all the partial pressures

Fick's law of diffusion

- Volume of gas is proportional to (Area/Thickness) x diffusion constant x pressure gradient
- Diffusion constant is proportional to gas solubility/√molecular weight

More here

# Cardiovascular physiology

**Cardiac output and blood pressure**

- Cardiac output = Stroke volume x Heart rate
- Blood pressure = Cardiac output x Systemic vascular resistance
- Mean arterial pressure = diastolic + (systolic - diastolic)/3
- Systemic vascular resistnace = (MAP - CVP/CO) x 80
- Pulmonary vascular resistance = (MPAP-PAWP/CO) x 80

**Oxygen transport**

- Oxygen content = cardiac output x (Hb x $SaO_2$ x 1.34) + (0.02 x $PaO_2$)
- Saturations = $HbO_2$ x 100%/Hb + $HbO_2$

**Laplace law**

- The pressure inside a sphere is proportional to the surface tension in the wall
- The pressure inside a sphere is inversely proportional to the radius of the sphere
- Wall ***stress*** is the wall ***tension*** divided by 2 times the wall thickness
- P = 2 x Surface Tension /radius

**Shock index**

- SI = HR/SBP

>0.9 is suggestive of circulatory failure

# Respiratory physiology

### Dead space

- Physiological dead space = anatomical + alveolar

*Explanations here*

### Resistance and compliance

- Total airway resistance = airway resistance + tissue resistance
- Compliance = Δ volume/ Δ pressure
- 1/total compliance = 1/lung compliance + 1/thoracic wall compliance

### Venturi

- Delivered FiO2 = (O2 flow rate + (0.21 x air flow rate))/Total flow rate

*The air flow rate can be calculated from the* ***entrainment ratio***

Here's our post on venturi stuff

### Bohr Equation

- VD/VT = PaCO2 - PeCO2/PaCO2

Explanation here

### Shunt Equation

- QS/QT = CCO2 - CaO2/ CCO2 – CvO2

Explanation here

### Alveolar gas equation

- PAO2 = FiO2 x (PATM – PH20) – PACO2/RQ

Explanation here

# Metabolic physiology

### Henderson-Hasselbalch equation and acid/base

- $pH = pK_a + \log([A^-]/[HA])$
- pH = -log10 [H+]

For an acid:

- pH = pKa + log[A-/HA]

For a base:

- pH = pKa + log[B/BA+]

More acid base stuff here

### Metabolic equivalent of task

- 1 MET = 3.5 ml O2/kg/min

Explanation here

### Anion Gap

- [Na+ + K+] - [Cl- + HCO3-]

Explanation here

### Serum osmolality

- (2x[Na+]) + [Glu] + [Urea]
- Osmolality = per kg, osmolarity = per litre
- Normally 275 - 290 mOsmol/kg
- Normal ***urine*** osmolality = 500 - 850 mOsm/kg

Fluids and stuff here

### Corrected sodium

- Corrected Na =Measured Na +2.4 x Glucose/100

# Neurophysiology

**Cerebral perfusion pressure**

- CPP = MAP - (ICP + CVP)

Explanation here

**Intracranial pressure**

- $ICP \propto Brain\ Volume + CSF\ Volume + Blood\ Volume$

where:

- **Compensation:** If one increases, the others must decrease to maintain normal ICP.
- **Decompensation:** Once compensation fails, ICP rises steeply.

**CSF production**

- CSF Production ≈ 0.3–0.4 mL/min ≈ 500 mL/day

**Cerebral blood flow**

- CBF=CPP/CVR

where CVR = Cerebrovascular Resistance

- Normal CBF = **50 mL/100g/min**
- **CBF is autoregulated** between a MAP of **50–150 mmHg**

**Cerebral oxygen consumption**

- $CMRO_2 = CBF \times (CaO_2 - CjvO_2)$

where:

- CaO2 = ***arterial*** oxygen content
- CjvO2 = jugular venous oxygen content

**Nernst equation**

- Ex = RT/zF x ln([X]extracellular/[X]intracellular) where:

- Ex = equilibrium potential for an ion
- R = universal gas constant
- T = temperature in Kelvin
- z = charge of the ion
- F = Faraday's constant

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# Paediatrics

**WETFLAG**

- Weight = (age+4) x 2
- Energy = 4 J/kg
- Tube = (age/4) + 4
- Fluids = 10ml/kg
- Lorazepam = 0.1mg/kg
- Adrenaline = 0.1ml/kg of 1:10 000 (1mg in 10ml)
- Glucose = 2mls/kg 10% dextrose

*Atropine = 20mcg/kg*

More here

**Fluid resuscitation**

- Maintenance=4 mL/kg/hr (first 10 kg)+2 mL/kg/hr (next 10 kg)+1 mL/kg/hr (>20 kg)

# Statistics

**Sensitivity and Specificity**

Sensitivity = *Likelihood of detecting a true case of the disease*

- true positive/(true positive + false negative)

Specificity = *Likelihood of testing negative if you don't have the disease*

- true negative/(true negative + false positive)

Positive predictive value = *Likelihood you actually have it if test positive*

- true positive/(true positive + false positive)

Negative predictive value = *Likelihood that a negative test means you don't have the disease*

- true negative/(true negative + false negative)

**Odds and relative risk**

When presented with a 2 x 2 table

Odds ratio = (a/b)/(c/d)

Relative risk = (a/(a + b))/(c/(c + d))

Absolute risk reduction = (c/(c + d)) - (c/(c + b))

Number needed to treat = 1/ARR

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*Let us know what we've missed and we'll add it in!*