Anaesthesia, Acute Physiology & Perioperative Medicine iBSc Modules

How to look after ill people well
Science behind it
How we can improve patient’s care
Amazing teachers, great feedback
Dr Rob CM Stephens

Consultant in Anaesthesia
Honorary Senior Lecturer UCL

Google ‘UCL stephens’
Video
= for interest and to give context
Introduction

What’s this lecture?
• How basic science underpins Medicine!
• Show relevance!
• Introduce some clinical concepts..
• Walk you through a patient’s journey
• Practice SBA’s
• Win £60
£60
Contents

Our patient, man or woman, from anywhere

Home symptoms
See GP
Tests at the GP’s
Sees Doctors at hospital
Needs surgery
Has surgery
....with complications
Goes home... at last!
We’re going to cover

- Anatomy
- Cancer
- Chest X Ray
- Electrocardiographs ECG
- Blood
- Anaemia
- Ethics – consent and confidentiality
- And more!!
Our patient
At Home

78 years old

Several chronic medical conditions..

Starts to feel discomfort “in the front of my stomach” ..

6 weeks go by......
“in the front of my stomach”
List the organs that *might* be involved...
Abdomen and Pelvis

• GI tract- stomach, small bowl, large bowl  
  Gastrointestinal

• Spleen

• Liver, Gall bladder, Biliary tree  
  Hepato-Pancreato-Biliary ‘HPB’

• Pancreas

• Kidney / Ureters / Bladder / Prostate / genitals  
  Urology

• Ovaries + Uterus/cervix  
  Gynaecology

• Blood vessels

• Muscles, connective tissue, nerves, bones  
  Vascular

• Skin  
  Orthopaedics

• Skin  
  Dermatology
Women have a Uterus, 2 Ovaries, Cervix & Vagina
History
Examination
Investigation
Management

Danger
Response?

AIRWAY
BREATHING
CIRCULATION
DISABILITY
EXPOSURE
Our patient is still at home

People comment on weight loss
Starts to notice altered bowl habits ...
...loose/harder..
Thinks there was blood in stool- not sure...
List the organs of the gastrointestinal tract - top to bottom!
Organs

- Mouth- Oropharynx
- Oesophagus
- Stomach
- Duodenum, Jejunum, Ileum, Caecum
- Ascending Colon, Transverse + Descending
- Sigmoid, Rectum + Anus
Thanks to Dr John B Bassett
GP visit

Wt loss of 1 stone in 10 weeks
Says he’s more breathless + tired

Initial Investigations
  Full blood Count
  Urea + Electrolytes

GP is concerned- refers to hospital
Full Blood Count

What is a Full Blood Count?
What is wrong with the FBC
<table>
<thead>
<tr>
<th>Test</th>
<th>Result</th>
<th>Normal Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>Haemoglobin</td>
<td>85g/L</td>
<td>man 130-180 g/L</td>
</tr>
<tr>
<td></td>
<td></td>
<td>woman 115-165 g/L</td>
</tr>
<tr>
<td>MCV</td>
<td>65</td>
<td>77 - 95 fL</td>
</tr>
<tr>
<td>White Cell count</td>
<td>8.5</td>
<td></td>
</tr>
<tr>
<td>Neutrophils</td>
<td>2 - 7.5 x 10^9/L</td>
<td>40-75%</td>
</tr>
<tr>
<td>Lymphocytes.</td>
<td>1.2 - 3.6 x 10^9/L</td>
<td>20-45%</td>
</tr>
<tr>
<td>Monocytes</td>
<td>0.2 - 1.0 x 10^9/L</td>
<td>2-10%</td>
</tr>
<tr>
<td>Eosinophils</td>
<td>0 - 0.4 x 10^9/L</td>
<td>1-6%</td>
</tr>
<tr>
<td>Basophils</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Platelets</td>
<td>167</td>
<td>150-400 x10^9/L</td>
</tr>
</tbody>
</table>
SBA
An approach to Anaemia diagnosis

MCV units femtoliters (fL, or $10^{-15}$L)
mean corpuscular volume

Dr Rakesh Popat UCL
Mechanism of Anaemia

- Reduced production of red cells/haemoglobin in the bone marrow
- Loss of blood from the body
- Reduced survival of red cells in the circulation
- Pooling of red cells in a very large spleen
Low mean corpuscular volume

**Microcytic Anaemia**

- Common causes of a microcytic anaemia
  - Defect in haem synthesis
    - Iron deficiency  Eg chronic blood loss
    - Anaemia of chronic disease
  - Defect in globin synthesis (thalassaemia)
    - Defect in α chain synthesis (α thalassaemia)
    - Defect in β chain synthesis (β thalassaemia)
Normocytic Anaemia = normal cell size

Failure of Red Cell Formation
   Anaemia of Chronic Disease
   Marrow suppression / failure /Infiltration/
Increased red cell loss/destruction
   Acute blood loss- initially
   Hypersplenism
Hemolytic disorders
Congenital conditions
   • Hemoglobinopathies eg HbS
   • Red Cell Membrane eg Hereditary spherocytosis
   • Red Cell Enzyme eg G-6-PD
high mean corpuscular volume

Macrocytic anaemia causes:

- Vitamin B12 or folic acid deficiency
- Use of drugs interfering with DNA synthesis
- Liver disease and ethanol toxicity
- Myelodysplasia
- Increase reticulocytes
  - 20% larger than mature red cells
  - Seen in Blood loss- often Reticulocytes on a blood film
  - Haemolytic anaemia

Dr Rakesh Popat UCL
Hospital Tests

• Sees Gastro-Intestinal Medicine Doctor
  – Weight loss
  – Altered bowl habit
  – Microcytic anaemia
  – ? Saw blood in stool?

• Decides to do endoscopy
  – Lower GI endoscopy
    = Colonoscopy
  - Upper GI Endoscopy
    = Oesophago-Gastro-Duodenoscopy = OGD
Video
What are the lines Valvulae conniventes, Plicae circulares or Haustra
Small vs Large bowl

Large bowel
- Bowel markings or folds do not fully cross the lumen of the bowel - the haustra
- Peripheral Position

Small bowel
- Bowel markings often continuous across the bowel – Valvulae Conniventes / Plicae Circulares
- Central Position
Valvulae conniventes, Plicae circulares
Anaesthetists are fab
A Tumour in the bowl
SBA
**Types of tumours - behavior**

## Classification of neoplasms

<table>
<thead>
<tr>
<th>Benign</th>
<th>Malignant</th>
</tr>
</thead>
<tbody>
<tr>
<td>• No local invasion</td>
<td>• Local invasion by definition</td>
</tr>
<tr>
<td>• No potential for metastasis</td>
<td>• Potential for metastasis by definition</td>
</tr>
<tr>
<td>• Slow rate of growth</td>
<td>• Variable growth rate</td>
</tr>
<tr>
<td>• Well-differentiated</td>
<td>• Variable degree of differentiation</td>
</tr>
</tbody>
</table>

![Image of a benign tumour](image1.png)

![Image of a malignant tumour](image2.png)
Malignant Tumours = cancer microscopy

- Pleomorphic - variation in cell size and shape

- Mitotic activity - Increased in more malignant tumors and often abnormal in shape

- Necrosis – tumour cells dying when they outgrow their blood supply. Common in fast growing tumours
A clinical picture of a removed tumour
Cancer Diagnosis - Investigations

Imaging eg USS, XR, CT, MRI

Microscopy

Immunohistochemistry

Genetics

Molecular techniques

• Cytology – cells shed from tumour
e.g sputum, urine, cervical smear, fluid or aspirated
(‘FNA’ = fine needle aspiration)

• Histology – a sample of tissue itself
  Biopsy – percutaneous or endoscopically
Resection at surgery – formal grading / stage
An infographic showing the number of deaths by cancer type for males and females in the UK. The most common causes of cancer-related deaths for both genders are lung and bowel cancer, followed by breast cancer. Other significant causes include prostate cancer, pancreas cancer, and leukemia. The infographic is sourced from Cancer Research UK's website: http://www.cancerresearchuk.org
Sees Surgeon

- History, Examination etc
- Discuss in blood transfusion

- Surgery, Chemo, Radiotherapy
  - +/- immune (mAb) +/- hormonal
- MDT discussion = Multi Disciplinary Team
- Discuss + has blood transfusion
- Consent for surgery
Ethics

Everyday practice

1: Consent

2: Confidentiality

Thanks UCL Medical Ethics and Law Unit
Ethics 1: Consent

Thanks UCL Medical Ethics and Law Unit
Capacity

- Understand information
- Retain information
- Weigh information and reach a conclusion
- Communicate the decision

UCL Medical Ethics and Law Unit
Requirements for valid consent

The patient must have the capacity to consent
- be competent

The consent must be freely given
- voluntary & no coercion

The person consenting must be suitably informed
- be adequately informed
- risks, benefit, alternatives
Do we need consent if...

It’s an emergency and they’re unconscious?
We discover something extra during surgery?
Pt details
Ethics 2: Confidentiality

Allows patients to seek medical help or to give doctors the information we need to provide good care.

But sharing appropriate information is essential to the efficient provision of safe, effective care.

GMC: “........information about patients will be held in confidence by their doctors”.

“You must be prepared to explain and justify your decisions and actions. “

More information at Confidentiality GMC 2013
Ethics 2: Confidentiality

- How can we breach it?

More information at Confidentiality GMC 2013
Ethics 2: Confidentiality

• Confidentiality vs need to unload after stress
• Is it OK to talk to friends / partner / parents?
• Is it OK to write on Facebook?
• Is it OK to Tweet?

• Be careful...

More information at Confidentiality GMC 2013
-But it’s relevant and important
-Mobile phones!
Ethics 2: Confidentiality

• No features identifying a patient
• Be careful about where you work- relative could identify a patient
• No features identifying a colleague

• Be very careful
  — on social media- effectively in public domain
  — in public – lifts, on phone etc
  — If you wouldn’t say it in public....

More information at www.gmc-uk.org
Back to our patient....
But the details to follow are relevant

Sees Anaesthetist Preassessment

• Takes bloods
• Electocardiograph ECG
• Discusses Transfusion
• Discusses Risk

History
Examination
Investigation
Treatment
SBA
ECG

Individual cells

Dr Jonathan Fry
Conduction Speed through the Heart

Atrial Depolarisation

Ventricular Depolarisation

Ventricular Repolarisation

Atrial repolarisation
ECG

• ECG is electrical activity of heart
• Measured by leads on chest normally
• 12 ‘leads’ =
  – 6 chest leads are physical electrical leads
  – 6 limb leads are electrically computed leads
6 Chest leads

Six positive electrodes placed over specific regions of the heart

Cardiovascular Physiology Concepts. www.cvphysiology.com Richard E. Klabunde, PhD
ECG

• 12 ‘leads’ =
  – 6 chest leads are physical electrical leads
  – 6 limb leads are electrically computed leads
You won’t have to fully interpret 12 lead ECG’s!
Limb leads- physical placement

4 physical leads are electrically computed to make 6 limb leads on the ECG.
‘6 Limb leads’

Dr Jonathan Fry
You won’t have to fully interpret 12 lead ECG’s!
You won’t have to fully interpret 12 lead ECG’s!

Normal ECG
ECG interpretation

Rate
Rhythm
Axis

P wave
PR interval
QRS complex
ST segment
T wave
QT interval

Put it all together and summarise findings

Dr Jonathan Fry
Normal ECG

You won’t have to fully interpret 12 lead ECG’s!
Our Patient’s ECG

RHYTHM STRIP: II
25 mm/sec; 1 cm/mV

3 AUG 92 14:21:22
• Traces of Atrial Fibrillation or normal?

• Problems with AF
£60
Break

• Quiz

• https://www.surveymonkey.com/r/WPY6SFF
£60
SBA
Autonomic Physiology

Metabotropic – via secondary messenger vs
Ionotropic – form an ion pore

Parasympathetic
- synapse (ACh, Nicotinic) near organ
- postganglionic (ACh Muscarinic)

Sympathetic
- synapse (ACh, Nicotinic) in Thoracic Chain, near spinal cord
- postganglionic (NA $\alpha_{1,2}$ & $\beta_{1,2,3}$ adrenoceptor)
Our patient ...discusses Transfusion

Why discuss?
• Patients need to know what’s going to happen
• Side effects
• Some people don’t want eg Jehovah’s Witness

Must discuss
Discusses Transfusion

Side effects
Side effects of blood products

• Infections
  – Hepatitis BC, HIV, other viruses
• Immune
  – Major ABO reactions
  – Other immune
• Iron overload- RBC
• Other side effects-usually from lots of blood
  – cold, coagulation, low Ca$$^{++}$$, high K$$^+$$
White Cells

Whole Blood

Red Cells

Platelets

Plasma

- FFP (fresh frozen plasma)
- Cryoprecipitate
- Plasma for fractionation (not UK) (pools of thousands of donors)

albumin
factor VIII: IX immunoglobulins
anti-D etc
Cryoprecipitate

Platelets

Blood

Packed Red Cells

Hostoglobin

O₂ carriage

Low Plt number

Abnormal Plt Fn

FFP

Fresh Frozen Plasma

Clotting Factors

Fibrinogen

Fibrinogen
Antibodies

<table>
<thead>
<tr>
<th></th>
<th>A Antibodies</th>
<th>B Antibodies</th>
<th>A + B Antibodies</th>
<th>Plasma</th>
<th>Frequency UK</th>
</tr>
</thead>
<tbody>
<tr>
<td>O Cells</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>A Cells</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>B Cells</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>AB Cells</td>
<td></td>
<td></td>
<td></td>
<td></td>
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80+% Rhesus D positive- have D antigen on cells = Rhesus Factor
80% of Rhesus –ve will develop antibodies if have Rh+ transfusion

Which is the ‘Universal donor’?

Which is the ‘Universal recipient’?

Many other red cell antigen groups eg Kell, Lewis, Duffy, Kidd ++

NBTS UK data  www.blood.co.uk
<table>
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<th>A Antibodies</th>
<th>B Antibodies</th>
<th>A + B Antibodies</th>
<th>Plasma</th>
<th>Frequency UK</th>
</tr>
</thead>
<tbody>
<tr>
<td>O Cells</td>
<td></td>
<td></td>
<td>yes</td>
<td>AB Ab</td>
<td>47%</td>
</tr>
<tr>
<td>A Cells</td>
<td></td>
<td></td>
<td>yes</td>
<td>B Ab</td>
<td>39%</td>
</tr>
<tr>
<td>B Cells</td>
<td>yes</td>
<td></td>
<td></td>
<td>A Ab</td>
<td>10%</td>
</tr>
<tr>
<td>AB Cells</td>
<td></td>
<td></td>
<td></td>
<td>No Ab</td>
<td>4%</td>
</tr>
</tbody>
</table>

80+% Rhesus D positive- have D antigen on cells = Rhesus Factor
80% of Rhesus –ve will develop antibodies if have Rh+ transfusion

Which is the ‘Universal donor’  **O**

Which is the ‘Universal recipient’  **AB**

Many other red cell antigen groups eg Kell, Lewis, Duffy, Kidd ++

NBTS UK data  www.blood.co.uk
SBA
Genetics of ABO

Parent 1
Genetics AO or BO
or OO

Parent 2
Genetics AO or BO
or OO

Patient Blood group 0
Genetics 00
SBA
Haemoglobin

Normal
Haemoglobin A   2 α and 2 β chains
Haemoglobin A2  2 α and 2 δ chains
Haemoglobin F   2 α and 2 γ chains

Haemoglobin S replaces both β-globin subunits in the haemoglobin
The gene defect is a known mutation of a single nucleotide change (A to T) of the β-globin gene, which results in glutamic acid (E/Glu) being substituted by valine (V/Val) at position 6

Low oxygen tension - sickling - damage the cell membrane - rigid blood cells can’t deform as they pass through narrow capillaries, leading to vessel occlusion and ischaemia.

Homozygous- both copies of the gene- more affected person  
Heterozygous- ‘carrier’ – will likely not be aware
Transfusion Errors!

- Clinical and Lab Errors
- 2013 deaths
  - 12 after ABO incompatible Transfusion
    - 5 clinical, 7 Laboratory
  - 22 deaths due to other causes
- 4 parts to a patients Identity
  - Blood / CXR / ECG / patient notes / consent etc etc

But important!

Boring

.....but v important!!

SHOT 2013 report
Our Patient has surgery...

- Colectomy = col.....ectomy
  - Right / left / hemi- / total
- What are you going to do with bowl end?!
- Stoma vs connect up
Surgery
Surgery is a big deal

- Needs Anaesthesia
  - “will I wake up?”
  - “will I wake up during the surgery?” = awareness
- Patients often have complications – minor / major
- Pain after / can’t work / do activities
- May never recover same function
- May die

- Sympathetic response, physical challenges, inflammation
<table>
<thead>
<tr>
<th>Procedure</th>
<th>Hospital Mortality %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Large intestine; complex major procedure</td>
<td>22.4</td>
</tr>
<tr>
<td>General abdominal; major &gt; 69 years</td>
<td>15.8</td>
</tr>
<tr>
<td>Complex hip or knee joint revision</td>
<td>11.6</td>
</tr>
<tr>
<td>Elective abdominal vascular surgery</td>
<td>7.4</td>
</tr>
<tr>
<td>Coronary Artery Bypass Graft only</td>
<td>1.5</td>
</tr>
<tr>
<td>Primary hip replacement</td>
<td>0.4</td>
</tr>
</tbody>
</table>

Pearce 2006
Risk video
SBA
During surgery

• Cardiovascular challenges – equations
• Fluid challenge
• Cardiac Output measurement
SBA
Equation 1

Mean Arterial Pressure = Cardiac Output \times Systemic Vascular Resistance

\[
\text{MAP} - \text{CVP} = \text{CO} \times \text{SVR}
\]

MAP & CO measured
SVR calculated- not measured directly

‘Cardiogenic’ = of the heart
‘Vaso...Veno ...dilation/constriction’
Equation 1 implication

Mean Arterial Pressure = CO \times SVR

2 ways to alter blood pressure

‘Pathology’ of low blood pressure

CO  Cardiac causes or changes in blood volume
SVR  Sepsis and Anaphylaxis

Myocardium- muscle
Rhythm- rate
Valves - forward flow
Oxygenated blood coming back to the heart = normal venous return
Relax + fill properly
Equation 2

The amount of Oxygen leaving the heart
.....in the blood each minute =
called Oxygen Delivery = \( \text{DO}_2 \)

= amount of blood pumped each minute
\( \times \) the amount of oxygen in the blood

\( \text{SV} \times \text{HR} \)
\( = \text{CO} \times \text{Oxygen content of blood} \)

Haemoglobin concentration
\( \% \text{HbO}_2 \)
saturation
Equation 2 Implications

Oxygen Delivery $DO_2$

$DO_2 = CO \times \text{Oxygen content}$

reduced $DO_2$

$\downarrow CO$  $\downarrow \text{SV x HR}$  $\downarrow \text{Hb O}_2\% \text{ saturation}$

$\downarrow \text{Haemoglobin}$

Measure SV and HR
Fluid challenge

- 300ml Intravenous Fluid
- 300ml Intravenous Fluid
- 300ml Intravenous Fluid

Stoke volume (mL)

Left Ventricular End-Diastolic Pressure (mmHg)
Doppler
Hartmann’s Bag
Doppler
Extrapolations of the Frank-Starling relationship is....?

Data/SBA on Curves – which one?

- B blockers
- Heart failure
- Increased inotropy
- Response to bleeding = sympathetic activation
- Vasodilation = less resistance to flow
Stroke volume (mL) vs. Left Ventricular End-Diastolic Pressure (mmHg)
Ways to measure Cardiac output

Oesophageal Doppler Monitor Picture
Ways to measure Cardiac output

Oesophageal Doppler Monitor

Pulmonary artery catheter
Ways to measure Cardiac output

Oesophageal Doppler Monitor
Pulmonary artery catheter
ECHO cardiography
– only one gives structure & function
Ways to measure Cardiac output

Oesophageal Doppler Monitor
Pulmonary artery catheter
ECHO cardiography
– only one gives structure & function

Dye dilution LiDCO:
Pulse contour analysis: LiDCO and PiCCO
Break No 2
SBA
Planned after surgery

Pain relief = analgesia
Fluid therapy – if they can’t drink
Deep Vein Thrombosis prevention = DVT prophylaxis
Nausea and vomiting
Anti-constipation drugs
Exercise/ Mobilise / Eat and drink
Virchow’s Triad

- Stasis
- Venous
- Hypercoagulability
- thrombosis

- Arterial
- Vessel
- wall injury
- thrombosis
What are the risk factors for VTE?

Risk factors:
- Age > 60 years
- Significant ↓ mobility
- Surgery
- Certain medical conditions
- Abnormal clotting conditions
- Pregnancy
- HRT or 'pill'
- History of VTE
- Active cancer
- Dehydration

(list not exhaustive)

Dr Hannah Cohen
Our Patient

- Woken up after surgery
- Pain is OK, breathing OK
ICU Patient
Our Patient; Day 2 post op

- Notices harder to breathe
- Can’t finish speaking his/her sentences
- Nurses: respiratory rate 24 /min
- Nurses: Oxygen Saturation $\text{SaO}_2$ 88%

- What could cause this?
Postoperative Complication 1

Shortness of Breath

- Hospital acquired pneumonia
- Atelectasis = areas of lung collapse
- Pulmonary Embolism
- Pulmonary Oedema = Cardiac Failure
- Pneumothorax
On Examination

**Cardiovascular** Feels warm to touch. HS I + II + O.

**Respiratory**
- Inspection
- Palpation
- Percussion
- Auscultation

**Neurological**
- Alert, orientated, GCS 15/15

**Peripheral vascular**
- All peripheral pulses palpable

**Abdominal**
- Inspection
- Palpation
- Percussion
- Auscultation

---

**History**

**Examination**

**Investigation**

**Treatment**
What you going to do?

**U**rine?
**B**loods?
**E**CG?
**X**-Ray: Chest X-Ray?

**Special investigations:** ABG, sputum culture, blood cultures

**Mnemonic:** UBEXS
SBA
Postoperative Complication 1

- Pneumonia = lower Respiratory Tract Infection

- Community vs Hospital Acquired

- Infections causing shortness of breath in UK
  - Bacterial
  - Viral
  - Fungal
Infections

**Bacteria**
- Prokaryotes – no nucleus or organelles
- Gram stain +/- peptidoglycan
- Antibiotics useful
- Bacilli/rod Cocci Spirochates
- Release toxins

**Virus**
- Small + Inert
- Dependence on host DNA or RNA

**Protozoa**
- Eukaryote, Unicellular
- Complex life cycles
- No vaccines
- Usually good treatment/prevention

**Fungi**
- Eukaryotes,
  - Common in Environment
  - 1. Yeasts (unicellular),
  - 2. Moulds (filamentous)
  - 3. Dimorphic – either form

**Helminths**
- Eukaryotes, complex, multicellular
- Complex lifestyle
- Tapeworms (cestodes)
- Flukes (trematodes)
- Round worms (nematodes)
Common Bacterial causes: Community Acquired Pneumonia

- Extracellular organisms:
  - *Streptococcus pneumoniae* (>50%)
  - *Haemophilus influenzae* (10%)

- Intracellular organisms (“atypicals“):
  - *Mycoplasma pneumoniae* (10%)
  - *Legionella pneumophila* (2%)
  - *Chlamydia pneumoniae* and *C. psitacci*
  - *Coxiella burnetti*

- Tuberculosis
Common Bacterial causes of Hospital Acquired pneumonia

- *Pseudomonas aeruginosa*
- *Klebsiella species*
- *Escherichia coli*
- *Acinetobacter species*
- *Staphylococcus aureus*
- *Streptococcus pneumoniae*
- *Haemophilus influenzae*

ATS 2004
Gram Positive vs Gram Negative

<table>
<thead>
<tr>
<th></th>
<th>Gram Positive</th>
<th>Gram Negative</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cell Wall thickness</td>
<td>20-80 nm</td>
<td>10 nm</td>
</tr>
<tr>
<td>Number of layers in wall</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Peptidoglycan</td>
<td>high</td>
<td>low</td>
</tr>
<tr>
<td>Lipid/Lipoprotein %</td>
<td>low</td>
<td>high</td>
</tr>
<tr>
<td>Releases</td>
<td>Sometime exotoxin</td>
<td>Endotoxin =lipopolysaccharide</td>
</tr>
<tr>
<td>Lipotechoic acid</td>
<td>yes</td>
<td>no</td>
</tr>
<tr>
<td>Penicillin Sensitive</td>
<td>yes</td>
<td>less</td>
</tr>
</tbody>
</table>

Thanks Dr TV Rao
BACTERIA SHAPES

SPHERES (COCCI)
- Diplococci
  (Streptococcus pneumoniae)
- Tetrad
- Staphylococci
  (Staphylococcus aureus)

RODS (BACILLI)
- Streptococci
  (Streptococcus pyogenes)
- Chain of bacilli
  (Bacillus anthracis)
- Flagellate rods
  (Salmonella typhi)
- Spore-former
  (Clostridium botulinum)

SPIRALS
- Vibrios
  (Vibrio cholerae)
- Spirilla
  (Helicobacter pylori)
- Spirochaetes
  (Treponema pallidum)

TLC Product 2014
How Antibiotics Work

- **Cell Wall Synthesis**
  - D-cycloserine
  - Vancomycin
  - Bacitracin
  - Penicillins
  - Cephalosporins
  - Cephamycins

- **DNA Synthesis**
  - Metronidazole
  - Quinolones

- **DNA Gyrase**
  - Rifampicin

- **RNA Polymerase**
  - Rifampin

- **Folate Synthesis**
  - Sulphonamides
  - Trimethoprim

- **Cell Wall Integrity**
  - β-lactamases

- **Transcription**

- **Replication**

- **Translation**
  - Protein Synthesis
    - 50s inhibitors
    - Erythromycin
    - Chloramphenicol
    - Lincomycin
  - Protein Synthesis
    - 30s Inhibitors
    - Tetracyclines
    - Streptomycin
    - Spectinomycin
    - Kanamycin

- **Cytoplasmic Membrane**
  - Phospholipid Membranes
  - Polymyxins
SBA
Antibiotic resistance

Health Protection Agency 2004-2008/NAO  Cefotaxime resistance
Bacterial classification

What when how
Viral classification

Possible structural components:
- Nucleic acid
- Nucleoprotein
- Capsid forming virus structure
- Envelope from host cell
- Virus proteins

Zoonotic viral classification:
- **ds DNA**
  - Herpesviruses
  - Poxviruses
  - Adenoviruses
  - Hepadnaviruses
- **ss DNA**
  - Paroviruses
- **+ss RNA**
  - Picornaviridae
    - Caliciviruses
    - Togaviruses & Flaviviruses
    - Coronavirus
- **−ss RNA**
  - Paramyxoviridae
  - Orthomyxoviridae
  - Arenaviruses
  - Rhabdoviridae
- **+ss RNA**
  - Retroviridae (HIV)

What when how
Postoperative Complication 2

Day 3
Our patient’s shortness of breath worsens
Someone takes an ‘arterial blood gas’

Blood from an artery
  blood from lungs - left heart – aorta….
  radial artery
Arterial blood gas
Lots of information!

- pH
  - pH - a measure of acidity / alkilinity
- pCO₂
- pO₂
- HCO₃⁻
- BEx
- Lactate
- Hb,
- Na⁺, K⁺ etc etc

Respiratory- ventilation

Acid base

Metabolic

Oxygenation

Other measurements
Arterial blood gas
Lots of information!

**pH**

\[ \text{pH} - H^+ \text{ acid} \quad \text{more } H^+ \quad \text{vs} \quad \text{less } H^+ \]

**pCO\(_2\)**

Respiratory- ventilation- breathing

\[ \text{CO}_2 + \text{H}_2\text{O} \quad \leftrightarrow \quad \text{H}_2\text{CO}_3 \quad \leftrightarrow \quad \text{H}^+ + \text{HCO}_3^- \]

**HCO\(_3^-\)**

Metabolic= everything apart from C0\(_2\)

= everything apart from lungs/ventilation

\[ \text{H}_2\text{CO}_3 \quad \leftrightarrow \quad \text{H}^+ + \text{HCO}_3^- \]
SBA
Blood Gas
<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
<th>Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>pH</td>
<td>7.22</td>
<td>low</td>
</tr>
<tr>
<td>pCO₂</td>
<td>4.5 kPa</td>
<td>normal</td>
</tr>
<tr>
<td>pO₂</td>
<td>7.8 kPa</td>
<td>low</td>
</tr>
<tr>
<td>HCO₃⁻</td>
<td>16.7 mmol/L</td>
<td>low</td>
</tr>
<tr>
<td>BE</td>
<td>-8.7</td>
<td>low</td>
</tr>
<tr>
<td>Lactate</td>
<td>4.8 mmol/L</td>
<td>high</td>
</tr>
</tbody>
</table>
Hypoxia

Hypoxia - inadequate oxygenation of the tissues.

Classified based on how it is produced:

**Hypoxic hypoxia**
Reduced PO$_2$ in arterial blood supply to the tissue

**Anaemic hypoxia**
Reduced O$_2$ carrying capacity of the arterial blood

**Stagnant hypoxia**
Inadequate blood flow to the tissues. PaO$_2$ may be normal

**Cytotoxic hypoxia**
Poisoning at the tissue level which stops oxidative metabolism.
Arterial blood gas

OK?

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
<th>Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>pH</td>
<td>7.52</td>
<td>high alkaline</td>
</tr>
<tr>
<td>pCO₂</td>
<td>2.5 kPa</td>
<td>low</td>
</tr>
<tr>
<td>pO₂</td>
<td>7.8 kPa</td>
<td>low</td>
</tr>
<tr>
<td>HCO₃⁻</td>
<td>24 mmol/L</td>
<td>normal</td>
</tr>
<tr>
<td>BE</td>
<td>-0.5</td>
<td>normal</td>
</tr>
<tr>
<td>Lactate</td>
<td>0.8 mmol/L</td>
<td>normal</td>
</tr>
</tbody>
</table>
• Our patient is given oxygen.....
Blood Gas
‘DRABC’

Danger?
Response
Airway
Breathing
Circulation
Disability
Respiratory Failure

= low Oxygen levels breathing room air
= low partial pressure Oxygen = \( \text{PaO}_2 < 8 \) kPa
Normal is \(~10-13\) kPa
= both ie type 1 and 2 respiratory Failure

Difference is

• Type 2 – failure of ‘ventilation’ as well
  = failure to move air in and out
  = can’t get \( \text{CO}_2 \) out of the body
  = so \( \text{CO}_2 \) builds up in the body – raised blood levels
Respiratory Failure

• Type 1 \( \text{PaO}_2 < 8 \text{kPa} \)  \( \text{PaCO}_2 \) normal/low
• Type 2 \( \text{PaO}_2 < 8 \text{kPa} \)  \( \text{PaCO}_2 \) raised

Assumption - breathing air
If \( \text{PaO}_2 > 13 \text{kPa} \) – must be breathing extra oxygen!
<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
<th>Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>pH</td>
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<td>normal</td>
</tr>
<tr>
<td>pCO₂</td>
<td>4.5 kPa</td>
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<tr>
<td>pO₂</td>
<td>7.8 kPa</td>
<td>low</td>
</tr>
<tr>
<td>HCO₃⁻</td>
<td>21.7 mmol/L</td>
<td>low/normal</td>
</tr>
<tr>
<td>BE</td>
<td>-2.7</td>
<td>low</td>
</tr>
<tr>
<td>Lactate</td>
<td>0.8 mmol/L</td>
<td>normal</td>
</tr>
</tbody>
</table>
Causes of type 1 respiratory failure

Anything that interferes with Oxygen Transfer ie Ventilation or Perfusion (regional V/Q)

- Pneumonia
- Pulmonary Embolus
- Pneumothorax
- Asthma
- Pulmonary Oedema
- Interstitial Lung Disease
- Pulmonary Artery Hypertension
- etc
Causes of type 2 respiratory failure

Anything that interferes with Ventilation

– Brain
  • Head Injury, Poisons, Drugs, Anaesthesia

– Spinal, Nervous, neuro-muscular junction
  • Guillain-Barré, Phrenic injury, NMJ blockers, spinal cord trauma, Myaesthenia gravis

– Muscular
  • Fatigue, (PE), Hypovolaemia

– Chest Wall / Cavity
  • Raised abdominal pressure, (pneumothorax), effusion, rib fracture

– Airways disease
  • Asthma, COPD, Upper airway Obstruction
any ventilation change

Brain
Brainstem
Nerves to Muscles
Spinal Cord
Upper Airway = above larynx
Lower Airway = below larynx
Intercostal Muscles
Diaphragm
Pleura
Lungs

anything involved in making us breathe
Normal Chest Radiograph
CT Scan
CT Scan
Our patient

- Gone through a lot
- Home day 12 after her/his hemicolecotomy
We’ve covered

- Abdominal anatomy
- Cancer
- Chest X Ray
- Electro Cardio Graphs ECG
- Blood Gas analysis/Hypoxia
- Blood products
- Anaemia
- Ethics – consent and confidentiality
- Infections
- Pneumonia, Pneumothorax
- 15 SBAs

Good luck
You all know so much more than we did!
Thank you for the slides from

Dr Rakesh Popat UCL Cancer Institute & UCLH
Dr John-Paul Westwood, Consultant Haematologist, UCLH
Dr Jonathen Fry, UCL and Royal Free Hospital
Dr Hannah Cohen, Haematologist, UCLH and UCL
Mr Peter Gogalniceanu, UCL

Google Images
Anaesthesia, Acute Physiology & Perioperative Medicine iBSc Modules

How to look after ill people well
Science behind it
How we can improve patient’s care
Amazing teachers, great feedback
Break CXR

- Different chest x rays.. What is..
- Normal including names, dob, no
- PPM
- Air under diaghram
- ECG dots
- CVP
- Intubated
- Lobar consolidation