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Cognitive Aids for the Management of Deteriorating Surgical Patients

1. Airway Compromise

START

1. Appoint **team leader**
2. **Declare:** "airway problem"
3. **Get help:** call the resuscitation team and supervisor
4. **Head tilt/chin lift** or **jaw thrust**
5. **Call for:** crash cart with defibrillator and bag-valve-mask
6. Apply **15L O₂** via **non-rebreathing mask**
7. Start NIBD every 5 min, apply saturation probe and continue monitoring
8. Get **suctioning** ready

DIRECT ACTION

1. **Clear** vomit, blood, saliva or foreign bodies from the airway (use suction)
2. **Check if the airway is open:**
 - movement of air during breathing
 - symmetrical chest excursions
 - no significant stridor / snoring
 - improvement of saturation
3. If the airway remains obstructed place an **Oropharyngeal ①** or **Nasopharyngeal airway ②**
4. Reevaluate if airway is open (see 2)
5. Remove saliva / vomit / blood by suctioning
6. Start **bag-valve-mask** ventilation with **15L O₂** and oral or nasopharyngeal airway in place
7. No pulse? Start **chest compressions** (algorithm 8)

1. Airway Compromise

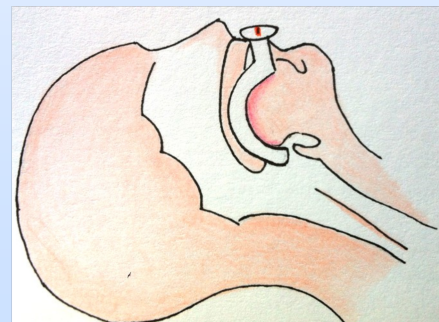
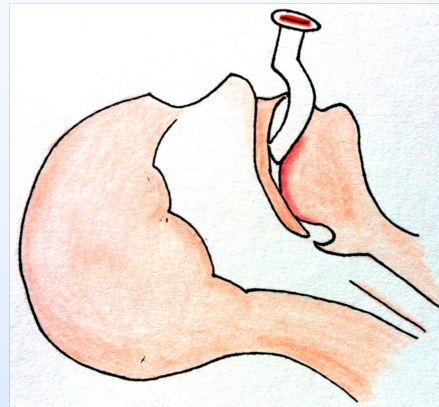
OROPHARYNGEAL AIRWAY

① INSERTION OF OROPHARYNGEAL AIRWAY (OPA)

Only patients with a reduced level of consciousness (GCS < 5) will accept an OPA. Beware of the aspiration risk when the gag reflex is still intact.

1. Determine the correct size
2. Apply upside down in the mouth
3. Rotate 180° when in contact with the posterior pharynx wall
4. Check if the airway is open

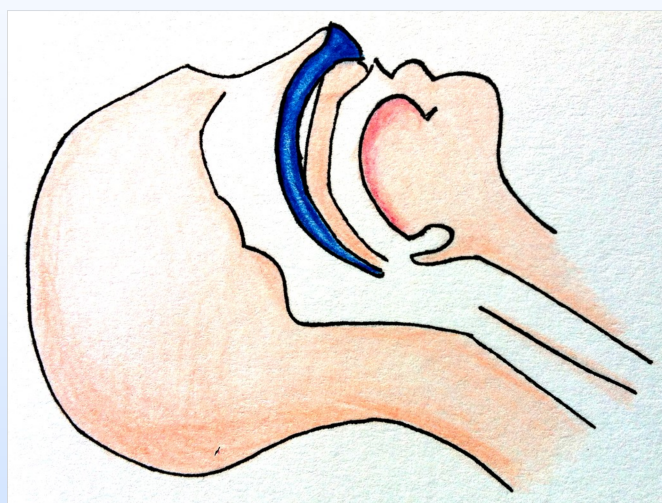
NB: Wrong size or displacement of the OPA can block the airway.



NASOPHARYNGEAL AIRWAY

② INSERTION OF NASOPHARYNGEAL AIRWAY (NPA)

If the patient does not accept an oral airway (gag reflex) consider placing a NPA. Use some gel to insert the NPA through one of the nostrils. Rotating the NPA may be necessary to place it correctly.



Sizes:

Large adult: 9 mm (24-27 french)

Regular adult: 7-8 mm (21-24 french)

Small adult: 6-7 mm (18-21 french)

2. Pneumothorax

START

1. Appoint **team leader**
2. **Declare:** "(tension) pneumothorax"
3. **Get help:** call supervisor
4. **Call for:** crash cart with defibrillator and bag-valve-mask, 18G cannula and equipment for chest drain.
5. Apply **15L O₂ via non-rebreathing mask**
6. Apply NIBP, measure every 2,5 min, apply pulse-oximetry, continue monitoring

DIRECT ACTION

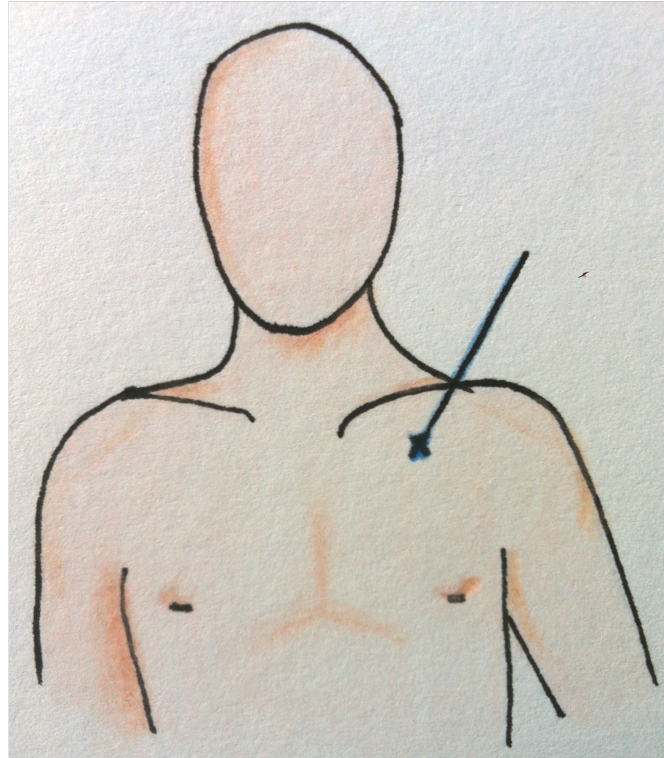
1. **Hemodynamically unstable? Direct decompression!**
Do not wait for imaging studies
Decompression is more important than chest compressions!
 - **Needle thoracostomy ①**
2nd intercostal space above 3rd rib **AND/OR**
 - **Thoracostomy ②**
mid-axillary line above the level of the nipple
 No pulse after decompression?
Start **chest compressions:** algorithm 8
2. **Hemodynamically stable?**
Chest imaging to confirm diagnosis
Prepare plan for chest drainage (with supervisor)

SECONDARY ACTION

1. Insert chest drain after decompression and attach to drainage system.
2. Perform a **chest X-ray**, consider a CT-scan
3. Monitor drain-output
Consider surgical intervention if:
 - massive leakage of air
 - active bleeding >1,5L
 - persisting bleed >250 ml/hour > 4 hours
4. Decide on management plan (with supervisor)

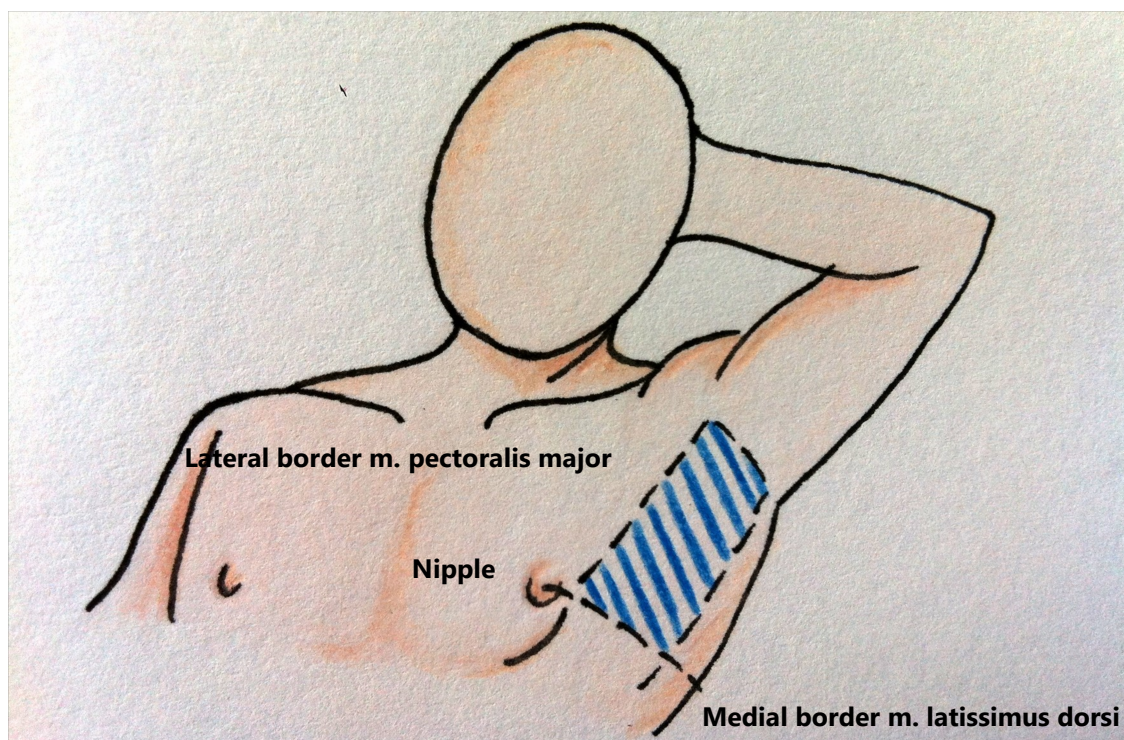
2. Pneumothorax

① NEEDLE THORACOSTOMY



Insert a large bore IV cannula (preferably in the second intercostal space in the midclavicular line over the 3rd rib) in the affected hemithorax.

② THORACOSTOMY



3. Pulmonary Embolism

START

1. Appoint **team leader**
2. **Declare:** "pulmonary embolism"
3. **Get help:** Consider calling the rapid response team and supervisor
4. **Call for:** crash cart with defibrillator and bag-valve-mask
5. Apply **15L O₂ via non-rebreathing mask**
6. Start NIBD every 5 min, apply saturation probe and continue monitoring

DIRECT ACTION

1. Consider **intubation**, call Anesthetic team
2. Anticipate cardiovascular collapse. No pulse? Start **chest compressions** and go to algorithm 8
3. Insert peripheral cannula (if not yet in situ)
4. Give a 250-500 ml crystalloid bolus if hypotensive, repeat if necessary
5. **DDX ①** (next page) and **treat accordingly**

SECONDARY ACTION

1. Take an **arterial blood gas**
2. Make an **ECG**
3. Perform a **chest X-ray**
4. Consider an **echocardiogram** or **CT** (if stable)
5. Consider **ICU admission**

3. Pulmonary Embolism

3

DDX 1

1. **Thromboembolism:**

- Start **thrombolytics** according to local protocol
- **Consult** vascular surgery and interventional radiology for option of local thrombolysis.

2. **Air embolus:**

Air can enter the vascular system through a central venous catheter or an arterial sheath.

- **Stop** air entry by aspirating the line until blood is withdrawn. Then close the line.
- Continue oxygen therapy (15L O₂ via non rebreathing mask)
- **Consider** hyperbaric oxygen therapy

3. **Fat embolism:**

Post orthopedic surgery or long bone fractures.

- Continue oxygen therapy (15L O₂ via non-rebreathing mask)

4. Shortness of Breath

START

1. Appoint **team leader**
2. **Declare:** "dyspnea"
3. **Get help:** Consider calling the rapid response team and supervisor
4. **Call for:** crash cart with defibrillator and bag-valve-mask
5. Apply **15L O₂ via non-rebreathing mask**
6. Start NIBD every 5 min, apply saturation probe and continue monitoring
7. Get suctioning ready

DIRECT ACTIONS

1. Is the **airway** open? No: algorithm 1
2. Is the patient **breathing?** No: algorithm 8
3. Set patient upright (if possible)
4. Check **breath sounds** bilaterally
5. Encourage patient to cough
6. Check chest-drain patency (swinging, bubbling)
7. Support ventilation with bag-valve-mask if patient (nearly) stops breathing
8. Check position of **pulse-oximetry** (poor peripheral circulation can disrupt the signal)
9. **DDX ①** (next page) and **treat accordingly**

SECONDARY ACTION

1. Insert peripheral cannula (if not yet in situ)
2. Take an **arterial blood gas**
3. Make an **ECG**
4. Perform a **chest X-ray**
5. Consider **CT**
6. Consider **ICU admission**

4. Shortness of Breath

4

DDX
1

1. **Hypoventilation:**
 - abdominal distention/ pain
 - restriction by corset/ bandages (loosen)
 - reduced level of consciousness: algorithm 13
 - sedative overdose
2. **Ventilation/perfusion mismatch:**
 - aspiration
 - asthma/COPD:
 - nebulize with salbutamol/ ipratropium bromide
 - atelectasis
 - pulmonary edema / fluid overload
 - consider 40-80 mg furosemide iv (if no hypotension)
 - pulmonary embolism: algorithm 3
 - pneumonia
 - pneumothorax: algorithm 2
 - mucus plug
3. **Diffusion problem:**
 - chronic pulmonary disease
4. **Increased ventilation due to metabolic problem:**
 - diabetic keto-acidosis
 - hyperlactatemia (shock, liver failure, ischemia)
 - sepsis/fever
 - thyrotoxic crisis
 - stimulant overdose

5. Allergic Reaction

5

START

1. Appoint **team leader**
2. **Declare:** "allergic reaction"
3. **Get help:** Consider calling the rapid response team and supervisor
4. **Call for:** crash cart with defibrillator and bag-valve-mask
5. Apply **15L O₂ via non-rebreathing mask**
6. Start NIBD every 5 min, apply saturation probe and continue monitoring

DIRECT ACTION

1. **Stop administration** suspected agent causing reaction
2. Do not remove the peripheral cannula
3. No **pulse?** Start **chest compressions:** algorithm 8
4. Position patient in **Trendelenburg**
5. Give **500 mcg adrenaline IM** in case of a compromised airway or hypotension
6. **Airway compromise or hypotension?** Call the resuscitation team
7. Give 500 ml crystalloids iv
8. Nebulize with 5 mg **salbutamol** in case of bronchospasm (wheezing)
9. Give 2 mg **clemastine** iv
- 10 Give 50 mg **ranitidine** iv
11. Give 100 mg **hydrocortisone** iv

5. Allergic Reaction

SECONDARY ACTION

1. Insert 2nd peripheral cannula
2. Take an **arterial blood gas**
3. Make an **ECG**
4. Perform a **chest X-ray**
5. Consider **ICU admission**
6. Determine serum **tryptase level** 90 minutes and 24 hours after the event
7. Refer to **allergologist**

6. Bleeding

6

START

1. Appoint **team leader**
2. **Declare:** "(massive) bleeding"
3. **First priority** is to **STOP THE BLEEDING: direct pressure** or **tourniquet** if external bleeding
4. **Get help:** call supervisor, Anesthetic team and the Operating Room coordinator
5. **Call for:** crash cart with defibrillator and bag-valve-mask
6. Apply **15L O₂ via non-rebreathing mask**
7. Start NIBD every 5 min, apply saturation probe and continue monitoring

DIRECT ACTION

1. Position patient in **Trendelenburg** in case of hypotension
2. Decide on **management plan** with supervisor
3. Prepare patient to go to the **operating room** or **interventional radiology** to stop the bleeding
4. If it does not delay transport of the patient to the operating room: insert a peripheral **cannula** (if not yet in situ) and/or take blood (Type & Screen, blood gas, FBC, PT, APTT, INR and fibrinogen)
5. **Permissive hypotension.** If Mean Arterial Pressure (MAP) <60 mmHg and/or patient unresponsive: give 250mL of crystalloids
6. Consider need for **massive transfusion protocol**

6. Bleeding

SECONDARY ACTION

Only perform these actions if the condition of the patient permits it and if it does not delay intervention to stop bleeding:

1. Give 1 gram **tranexamic acid** iv
2. **Reverse** anticoagulant drugs:
heparin → protamine iv: (10 mg protamine antagonizes 1000 IU heparin)
vit K-antagonist → 2500 IU Cofact iv
3. Take bloods: Type & Screen, blood gas, FBC, PT, APTT, INR, fibrinogen, consider thromboelastography)
4. Insert urine catheter

7. Bradycardia with hypotension

7

START

1. Appoint **team leader**
2. **Declare:** "bradycardia"
3. **Get help:** call the rapid response team, cardiologist and supervisor
4. **Call for:** crash cart with defibrillator with pacer mode and bag-valve-mask
5. Apply **15L O₂ via non-rebreathing mask**
6. Start NIBD every 5 min, apply saturation probe and continue monitoring

DIRECT ACTION

1. Attach **defibrillator** to patient
2. Insert peripheral cannula (if not yet in situ)
3. **DDX ①** (next page) and **treat accordingly**
4. Give **0,5 mg atropine iv** (repeat if necessary, max 3 mg)

SECONDARY ACTION

1. Take bloods: arterial blood gas, Hb, electrolytes, glucose, TSH, troponin
2. Make an ECG
3. Perform a **chest X-ray**
4. In case of **overdose** with:
 - betablockers: give 2-4 mg glucagon iv
 - Calcium channel blockers: give 1 gram calcium gluconate iv
5. Consider **ICU** admission

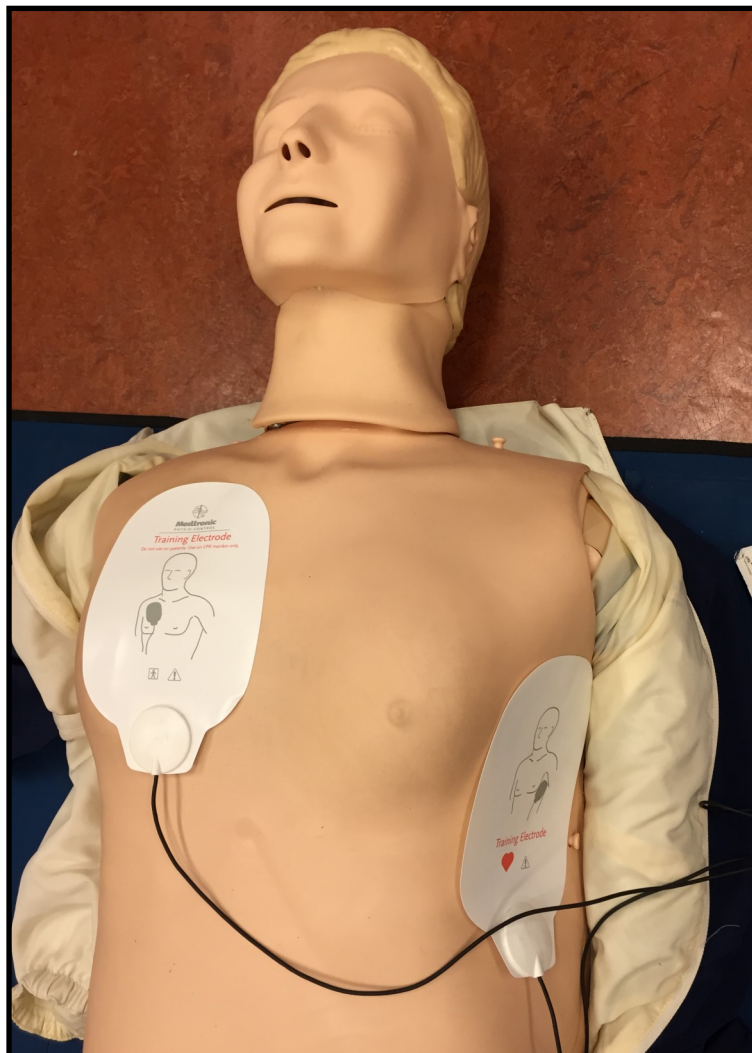
7. Bradycardia with hypotension

DDX 1

1. **Vagal:** e.g. vomiting
2. **Cardiac:** e.g. sick sinus syndrome, ischemia, conduction disorder
3. **Medication:** e.g. beta blockers anti-arrhythmic, psychotropic drugs, total epidural block
4. **Neurological:** e.g. coning (bradycardia with HYPERTension), neurogenic shock
5. **Metabolic:** electrolyte disorders, hypoglycemia
6. **Hypothermia**
7. **Hypothyroidism**

7

PLACEMENT OF DEFIBRILLATOR PADS



8. Cardiac arrest

8

START

1. Appoint **team leader**
2. **Declare:** "cardiac arrest"
3. **Get help:** call resuscitation team and supervisor
4. **Start timer**
5. **Call for:** crash cart, defibrillator and bag-valve-mask
6. Start **chest compressions** 100/min immediately
7. Attach **defibrillator** (see ③ next page) and turn the device on
8. Open the airway, insert oral airway, see algorithm 1:
9. Give 2 ventilations by bag-valve-mask with 15L O₂ after every 30 chest compressions
10. Use suction when necessary

DIRECT ACTION

1. Continue chest compressions 30:2 at a rate of 100/min and rotate person performing chest compressions every 2 minutes
2. In case no IV access: insert **Intraosseous needle**
3. Check rhythm. See ② on next page
4.
 - ▶ **Shockable:** defibrillate at 200 J
 - ▶ **Non shockable:** give 1 mg adrenaline iv/io
6. Resume chest compressions immediately at 100/min, 5-6 cm depth
7. **Check every 2 minutes:**
 - pulse (<10 sec) when absent:
 - rhythm? See ② next page
 - ▶ **Shockable:** defibrillate 360 J
Give amiodarone 300 mg and 1 mg of adrenaline iv/io after **3rd shock**:
 - ▶ **Non shockable:** give 1 mg iv/io adrenaline iv/io every 4 minutes
8. Identify and treat **underlying cause** using 4H/4T See ① next page

8. Cardiac arrest

① Discuss underlying cause (4H4T) in the team:

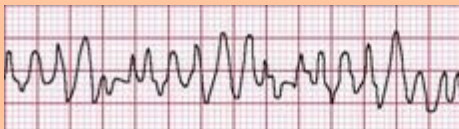
- | | |
|--|------------------------------------|
| 1. Hypoxia | 5. Thrombosis– pulmonary, coronary |
| 2. Hypovolemia | 6. Tamponade– cardiac |
| 3. Hypo-/hyperkalemia
other metabolic cause | 7. Toxins |
| 4. Hypo-/hyperthermia | 8. Tension pneumothorax |

8

② there are 2 types of cardiac arrest rhythms:

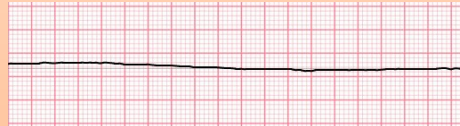
SHOCKABLE:

Ventricular tachycardia
Ventricular fibrillation



NON SHOCKABLE:

Asystole
Pulseless electrical activity

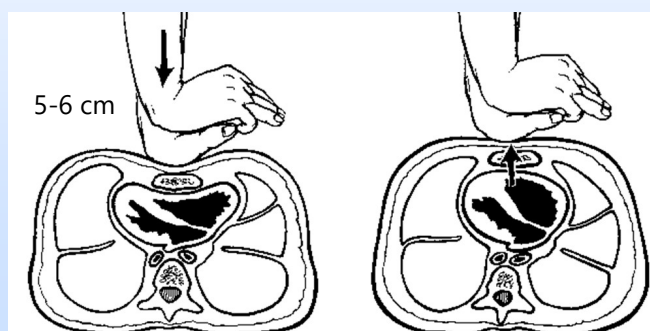


NB: it is NOT possible to assess rhythm with ongoing chest compressions!

③ PLACEMENT OF DEFIB-PADS and CHEST COMPRESSIONS



- Compress sternum 5-6 cm
- Allow complete chest recoil
- Avoid interruptions in CPR



9. Chest pain

9

START

1. Appoint **team leader**
2. **Declare:** "chest pain"
3. **Get help:** call the cardiologist supervisor and, in case of dyspnea/hypotension the rapid response team
4. **Call for:** crash cart with defibrillator and bag-valve-mask
5. **No Pulse?** Start **chest compressions:** algorithm 8
6. Apply **15L O₂ via non-rebreathing mask**
7. Apply NIBP, measure every 2,5 min, apply pulse-oximetry, continue monitoring
8. **DDX ①** (next page) and **treat accordingly**

DIRECT ACTION

In case of suspected cardiac ischemia:

1. Make a 12-lead ECG
2. Give **NTG** 1-2 puffs sublingual
3. **ST-elevations and/or no relieve of pain after NTG?**
Consult cardiology for possible intervention
4. Insert peripheral cannula (if not yet in situ)
5. Consider **20-80 mg furosemide iv** in case of acute heart failure (e.g. dys/tachypnea, pink/red froth, crepitations) and in **ABSENCE** of hypotension
6. Pain: give 2 mg morphine iv (titrate to NRS <4 max 10 mg)
7. Nausea: give 4 mg ondansetron iv
8. Aim for:
 - SpO₂ >95%
 - sinus rhythm <100/min
 - Hb > 6 mmol/L
 - glucose < 11 mmol/L
9. Consult Cardiac surgery if suspected papillary muscle, ventricular septum or free-wall rupture

9. Chest pain

SECONDARY ACTION

1. Take bloods: arterial blood gas, Hb, electrolytes, glucose, **cardiac enzymes** (CK, CK-MB and troponin T) at t=0, t=3, t=6, t=12 and t=24 hours
2. Consider imaging (chest X-ray, ultrasound, CT) depending on **DDX 1** (see below)

9

DDX 1

1. Cardiac/ major blood vessels:

- myocardial ischemia (+/- congestive heart failure)
- pericarditis
- cardiac tamponade
- heart failure with valve defects
- aortic dissection

2. Pulmonary e.g:

- tension pneumothorax: algorithm 2
- pulmonary embolism: algorithm 3
- pneumonia

3. Gastro-intestinal e.g:

- esophageal spasm/reflux
- perforation of stomach /duodenum
- pancreatitis
- cholecystitis

4. External e.g:

- herpes zoster
- costochondritis / muscle strain

10. Hypertension

START

1. Appoint **team leader**
2. **Declare:** "hypertension"
3. **Get help:** consider calling the rapid response team and supervisor
4. Apply **15L O₂ via non-rebreathing mask**
5. Start NIBD every 5 min, apply saturation probe and continue monitoring

10

DIRECT ACTION

1. Insert peripheral cannula (if not yet in situ)
2. **DDX ①** (see next page)
3. Check for medication error (check infusion pumps and infusions for peripheral nerve blocks / epidural analgesia)
4. Consult general medical team

SECONDARY ACTION

1. Take blood: arterial blood gas, Hb, electrolytes, creatinine, glucose, troponin
2. Consider consulting an ophthalmologist (retinal bleed, papillary edema)
3. Insert urine catheter
4. Consider an urine tox-screen
5. Make an ECG
6. Consider imaging (chest X-ray, ultrasound, CT-scan) depending on DDX
7. Consider **ICU** admission

10. Hypertension

DDX
1

1. Cardiovascular (e.g.)

- asymptomatic hypertension
- malignant hypertension (hypertensive encephalopathy, retinal bleed, papillary oedema and/or renal cause)
- myocardial infarction: algorithm 9
- heart failure
- aortic dissection

2. Neurologic (e.g.)

- increased intracranial pressure (bleed, infarction, tumor)
- autonomous dysfunction (Guillain-Barre, Shy-drager syndrome or spinal cord lesion)
- pain

3. Medication (e.g.)

- withdrawal of short-acting anti-hypertensive drugs (clonidine, betablocker etc.)
- sympathomimetics (amphetamines, adrenaline, noradrenaline, phenylephrine, terlipressine etc.)

4. Endocrine(e.g.)

- pheochromocytoma
- thyrotoxic crisis
- Conn syndrome
- Cushing syndrome
-

5. Pregnancy related (e.g.)

- (pre-) eclampsia

10

11. Hypotension

START

1. Appoint **team leader**
2. **Declare:** "hypotension"
3. **Get help:** Call the rapid response team and supervisor
4. **Call for:** crash cart with defibrillator and bag-valve-mask
5. Apply **15L O₂ via non-rebreathing mask**
6. **No Pulse?** Start **chest compressions:** algorithm 8
7. Apply NIBP, measure every 2,5 min, apply pulse-oximetry, continue monitoring

11

DIRECT ACTION

1. Position patient in **Trendelenburg**
2. Is blood pressure **measurement accurate?**
3. Insert peripheral cannula (if not yet in situ)
4. Give 250-500 ml crystalloids and consider further fluid boluses
5. **DDX ①** (see next page) and **treat accordingly**

SECONDARY ACTION

1. Take bloods: arterial blood gas, Hb, electrolytes, glucose, troponin
2. Make an ECG
3. Consider imaging (chest X-ray, ultrasound, CT-scan) depending on DDX
4. Consider **ICU** admission

11. Hypotension

DDX
1

1. **Hypovolemic (e.g.)**
 - hypovolemia: bleeding: algorithm 6
2. **Obstructive (e.g.)**
 - tension pneumothorax: algorithm 2
 - pulmonary embolism: algorithm 3
 - cardiac tamponade
3. **Cardiogenic (e.g.)**
 - myocardial ischemia: algorithm 9
 - arrhythmia: algorithm 7 or 12
 - heart failure (hypoxia, overdose/toxines, cardiac valve problems, cardiomyopathy)
4. **Distributive (e.g.)**
 - medication overdose (antihypertensives, sedatives)
 - anaphylaxis: algorithm 5
 - sepsis: algorithm 14
 - neurogenic in case of high spinal cord injury
 - transfusion reaction: algorithm 16

12. Tachycardia with hypotension

START

1. Appoint **team leader**
2. **Declare:** "tachycardia"
3. **Get help:** call the rapid response team, cardiologist and supervisor
4. **Call for:** crash cart with defibrillator and bag-valve-mask
5. Apply **15L O₂ via non rebreathing mask**
6. **No Pulse?** Start **chest compressions:** algorithm 8
7. Start NIBD every 5 min, apply saturation probe and continue monitoring

12

DIRECT ACTION

1. **Exclude compensated sinus tachycardia**
2. **DDX ①** (next page)
3. Insert peripheral cannula (if not yet in situ)
4. Make a 12-lead ECG
5. Attach defibrillator
6. Consider synchronized cardioversion if symptoms of shock are present **②** (next page):

SECONDARY ACTION

1. Take bloods: arterial blood gas, Hb, electrolytes, **cardiac enzymes** (CK, CK-MB and HS-troponin T), glucose
2. Consider imaging (chest X-ray, ultrasound, CT, CAG) depending on DDX
3. Treat the underlying cause (stop the bleeding, give a 250 ml fluid bolus, correct electrolytes etc.)

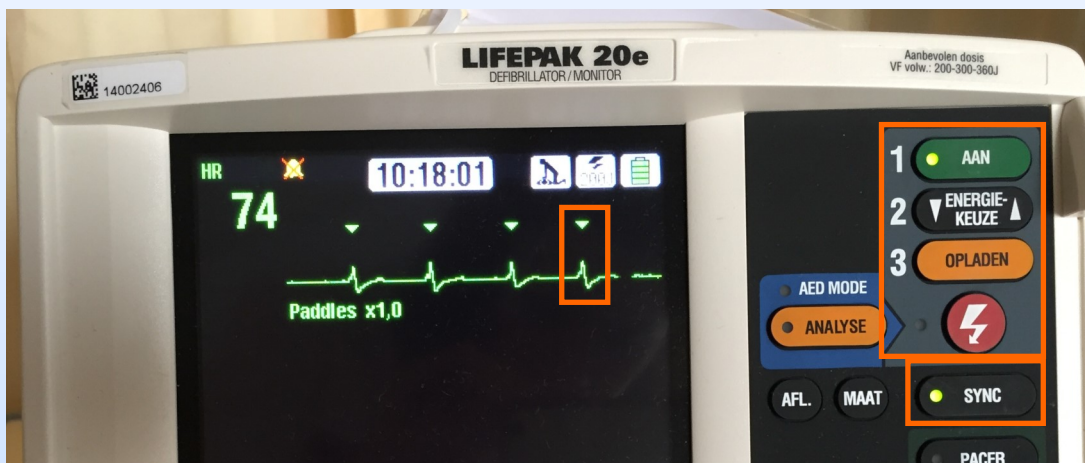
12. Tachycardia with hypotension

DDX 1

1. **Sinus tachycardia:** compensatory in bleeding/hypovolemia, pain, sepsis or fever
2. **Supraventricular tachycardia:**
 - primary: hereditary heart rhythm disorder
 - secondary: coronary artery disease, valve problems, anemia, electrolyte disorder, hypovolemia, hyperthyroidism
3. **Ventricular tachycardia:** 4H/4T: algorithm 8

② SYNCHRONISED CARDIOVERSION:

1. START in presence anesthesia/ RRT/ cardiology :
 - **sedation**
 - **press SYNC**
 - turn monitor to **DEFIB** modus
 - look for **spike on R-wave**
 - select energy level 200 J
 - **cardiovert** with 200 J
 - **activate the SYNC mode after every shock**



2. **Check rhythm:** rhythm restored? No:
 - select energy level 360 J and shock max 3x
 - give **amiodarone** 300 mg iv in 15 min
 - **repeat shock**
3. **No Pulse?** Start chest compressions: algorithm 8

13. Altered Mental Status

START

1. Appoint **team leader**
2. **Declare:** "altered mental status/ reduced level of consciousness"
3. **Get help:** Call the rapid response team and supervisor
4. **Call for:** crash cart with defibrillator and bag-valve-mask
5. Check if the **airway is open:** algorithm 1
6. **No Pulse?** Start chest compressions: algorithm 8
7. Apply **15L O₂ via non-rebreathing mask**
8. Start NIBD every 5 min, apply saturation probe and continue monitoring

DIRECT ACTION

1. Evaluate consciousness via **AVPU:**
A: Alert **V:** Verbale stimulus **P:** Pain stimulus **U:** Unresponsive
2. Look at the pupils **②** (next page)
3. Insert peripheral cannula (if not yet in situ)
4. **Convulsions?:** call rapid response team and make sure patient doesn't fall or hurts himself
5. Check if the **airway** is open: algorithm 1
6. **DDX ①** (next page) and **treat accordingly**

SECONDARY ACTION

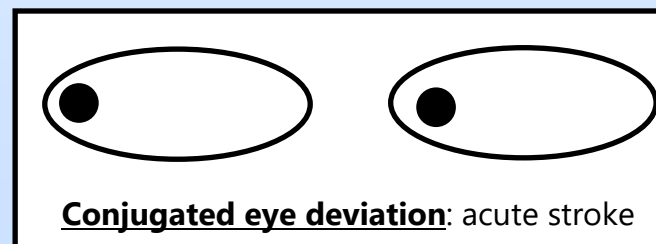
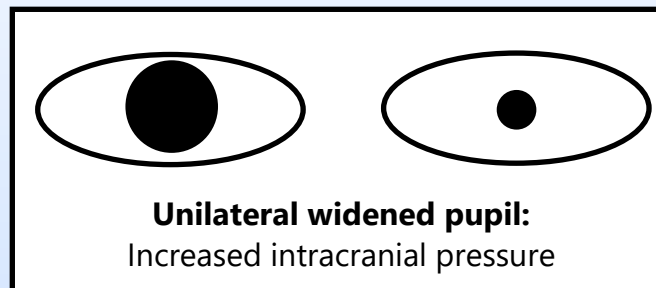
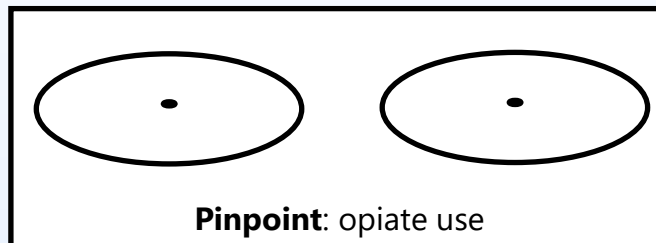
1. Take bloods: arterial blood gas, FBC, electrolytes, glucose, TSH, troponin, liver- and kidney function, ammonia and clotting studies.
2. Check for **medication** error or sedatives (e.g. opiates, benzodiazepines etc.)
3. Make a 12-lead ECG
4. Consider head CT-scan depending on DDX
5. Consider **intubation** and **ICU admission**

13. Altered Mental Status

DDX 1

1. Hypoglycemia: 50-100 mL glucose 20% iv OR 1 mg Glucagon IM/SC
2. Hypercapnia: consult **ICU** for ventilation support
3. Opiate overdose: give 40-400 mcg (=0,04-0,4 mg) **naloxone** iv
4. Benzodiazepines overdose: give 50-500 mcg (=0,05-0,5 mg) **flumazenil** iv
5. Hepatic encephalopathy
6. Intracranial event (bleed, infarction, infection)
7. Epilepsy or postictal status

2 PUPILS



14. Infection and Sepsis

START

1. Appoint **team leader**
2. **Declare:** "suspicion of sepsis"
3. **Get help:** consider calling the rapid response team and supervisor
4. Apply **15L O₂ via non-rebreathing mask**
5. Start NIBD every 5 min, apply saturation probe and continue monitoring

DIRECT ACTION

1. Position patient in **Trendelenburg** if hypotensive
2. Insert peripheral cannula (if not yet in situ)
3. Give 250-500 ml crystalloids iv and consider further fluid boluses
4. Consult medical microbiology for choice of antibiotic treatment.

14

SECONDARY ACTION

1. Take bloods: **arterial blood gas**, Hb, thrombocytes, leukocytes, CRP, electrolytes, kidney- and liver function, **blood cultures**
2. Find the cause of sepsis
 - comprehensive physical examination (ulcers)
 - check for line infection
 - take blood-, urine- and sputum cultures
 - consider imaging (chest X-ray, ultrasound, CT-scan)
4. Insert urine catheter to monitor urine production
5. Consider need for an intervention? (drainage of an abscess, amputation of infected diabetic foot, laparotomy for anastomotic leakage etc.)
6. Consider **ICU admission**

14. Infection and Sepsis

1. **Consult RRT and consider ICU admission when:**
 - GCS < 15
 - Respiratory rate > 22/min
 - Systolic blood pressure < 100 mmHg
2. **Septic shock** is likely when:
 - mean arterial pressure (MAP) < 65 mmHg
 - Lactate > 2 mmol/L despite fluid resuscitation

Consult RRT immediately for **ICU admission**

Time course for the development of complications

Think of the postoperative time frame when investigating the cause of infection.

postoperative complications

Immediate (0-1 days)	Early (1-5 days)	Late (>5 days)
Shock: - Hemorrhagic - Cardiogenic	Pulmonary atelectasis	Wound infection/dehiscence
Arrhythmia	Ileus	Intra abdominal collections
	Fluid balance	DVT/PE
	Visceral injury	Anastomotic leak
	Infectious complications (pneumonia, UTI)	
SIRS	Delirium	Lines

15. Nausea and vomiting

START

1. Appoint **team leader**
2. **Get help:** consider calling the rapid response team and supervisor
3. **Call for:** consider need crash cart with defibrillator and bag-valve-mask
4. Get suction ready
5. Start NIBD every 5 min, apply saturation probe and continue monitoring

DIRECT ACTION

1. Put the patient in upright position or sideways to prevent **aspiration**
2. Clear the airway, see: algorithm 1
3. Is the **patient breathing**? No: algorithm 8
4. Consider benefits of giving oxygen against risk of aspiration when vomiting when applying non re-breather mask
5. **DDX ①** (next page) and **treat accordingly**

15

SECONDARY ACTION

1. Insert peripheral cannula (if not yet in situ)
2. Correct electrolytes if necessary
3. Consider anti-emetics (NB: contra-indications):
 - 4-8 mg ondansetron iv
 - 10-20 mg metoclopramide iv

15. Nausea and vomiting

DDX
1

1. **Accompanying sign of (e.g.)**
 - myocardial infarction: algorithm 9
 - hypotension: algorithm 11
2. **GI-problems (e.g.)**
 - intestinal obstruction (volvulus, tumor, strand, cholelithiasis, etc.)
 - paralytic ileus
 - peritonitis (local/generalized)
 - gastro-enteritis
3. **Urogenital (e.g.)**
 - testicular /ovarian torsion
 - prostatitis
4. **Neurologic (e.g.)**
 - increased intracranial pressure (bleed, infarction, tumor)
 - meningitis
 - migraine
5. **Medication (e.g.)**
 - opiates
 - chemotherapy

16. Transfusion reaction

START

1. Appoint **team leader**
2. **Declare:** "transfusion reaction"
3. **Get help:** consider calling the rapid response team and supervisor
4. **Call for:** consider need for crash cart with defibrillator and bag-valve-mask
5. Check if the **airway** is open: algorithm 1
6. **No Pulse?** Start chest compressions: algorithm 8
7. Apply **15L O₂ via non rebreathing mask**
8. Start NIBD every 5 min, apply saturation probe and continue monitoring

DIRECT ACTION

1. **Stop transfusion**
2. Do not remove the peripheral cannula
3. Attach **new IV-fluid lines with crystalloids**
4. Treat **hypotension:** algorithm 11
5. **DDX ①** (next page) and **treat accordingly**

16

SECONDARY ACTION

1. **Check administered blood product:**
 - patient ID
 - product number
 - expiration date
 - blood type
2. **Report transfusion reaction** to the transfusion lab:
3. Consult **hematology**
4. Take bloods as advised by hematology/ transfusion lab
5. Place urine catheter to monitor urine output
6. Consider **ICU admission**

16. Transfusion reaction

DDX

1

1. **Anaphylaxis:** algorithm 5
2. **Transfusion reaction with hemolysis:**
 - Anticipate diffuse intravascular coagulation (DIC)
 - Aim for urine output > 1 ml/kg/h, give crystalloid bolus of 250 ml and iv diuretics (furosemide or mannitol)
 - Give paracetamol or ibuprofen to treat fever
 - Suspected bacterial contamination of blood product? Treat as sepsis: algorithm 14
3. **Transfusion reaction with fever and without hemolysis:**
 - Give symptomatic treatment for fever
 - Suspected bacterial contamination of blood product? Manage as sepsis: algorithm 14
 - Take bloods: lactate + blood cultures
 - 2 g ceftriaxone + 5 mg/kg gentamicin
 - hypotension or lactate >4 mmol/L: give 250 ml crystalloids iv
4. **Transfusion Related Acute Lung Injury (TRALI) of Transfusion Associated Cardiac Overload (TACO):**
 - Consult Rapid Response Team and discuss need for **ICU** admission

17. Rationale

The mortality of surgical patients with multi-organ failure (MOF) can be as high as 50%. However, the development of MOF is detectable and treatable in an early stage. Studies show that in almost half of the cases, suboptimal care preceded an ICU (re) admission. It is therefore important to recognize postoperative complications early and treat them effectively. It may help to think about the risks of a complication that a specific patient develops after a certain treatment and the time course in which the complication occurs (see next page).

Approach

- Predict: Identify risk population
- Prevent: DVT prophylaxis, physical therapy etc.
- Early identification and adequate treatment of complications

Serious complications can often be prevented or reduced in severity by promptly initiating simple supportive measures such as oxygen and fluid therapy, diagnose and immediately initiating treatment such as starting antibiotics. If these steps are not taken (quickly) or when reevaluation of the effectivity of treatment so far does not occur, major problems may arise.

After initial management always:

- Reassess in 30-60 minutes;
- Has the intervention had an effect?
- Is further treatment necessary?

17. Rationale

postoperative complications

- General complications of surgery
 - hemorrhage
 - SIRS
 - venous thromboembolism
 - wound complications and surgical site infection
- Complications specific procedure
 - anastomotic leak, visceral injury
 - infection prosthetic material
 - dysfunction operated organ
- Complications related patient co-morbidity

Timing

postoperative complications

Immediate (0-1 days)	Early (1-5 days)	Late (>5 days)
Shock: - Hemorrhagic - Cardiogenic	Pulmonary atelectasis	Wound infection/dehiscence
Arrhythmia	Ileus	Intra-abdominal collections
	Fluid balance	DVT/PE
	Visceral injury	Anastomotic leak
	Infectious complications (pneumonia, UTI)	
SIRS	Delirium	Lines

18. ABCD Assessment

A: AIRWAY

OPEN an obstructed airway: see algorithm 1

LOOK: cyanosis, obstruction caused by blood, vomit or a foreign body, use of respiratory muscles, abnormal breathing pattern and/or low level of consciousness

LISTEN: stridor, hoarseness, gargling or snoring

FEEL: air moving with in- and expiration

TREAT: non-rebreathing mask 15L O₂, head tilt/chin lift, jaw thrust, suctioning, insert oral or nasopharyngeal airway (see algorithm 1)

B: BREATHING

Identify and treat a tension- or open pneumothorax, flail chest, massive hemothorax, and cardiac tamponade IMMEDIATELY

LOOK: cyanosis, respiratory rate, regularity and depth of breathing pattern, use of respiratory muscles, restriction of breathing because of distended abdomen, tight corset/bandage, check patency of chest drains if present

LISTEN: audible breathing, coughing, can the patient speak in full sentences? Listen to breath sounds

FEEL: chest excursions, subcutaneous emphysema, rib fractures

MEASURE: respiratory rate, peripheral oxygen saturation, take an arterial blood gas to determine PO₂ and PCO₂

TREAT: put the patient upright, start 15L O₂ via a non-rebreathing mask, support breathing if necessary with bag-valve-mask

Generate a DDX and treat accordingly

18. ABCD Assessment

C: CIRCULATION

Stop massive external blood loss **IMMEDIATELY using compression or tourniquet**

LOOK: external bleeding, pale gray, clammy patient, assess drain output, blood in gauze/bandages, bed

LISTEN: heart sounds, breath sounds crepitations (pulmonary edema; heart failure/ cardiogenic shock)

FEEL: cold or warm extremities, capillary refill

MEASURE: heart rate, blood pressure, take an arterial blood gas to determine lactate, consider echocardiogram

TREAT: **STOP THE BLEED,** is an intervention necessary (discuss with supervisor). If there is **no** suspicion of heart failure or active blood loss, give a 250 ml fluid bolus and reevaluate the patient within 30 min.

D: DISABILITY

Asses through AVPU:

A: Alert **V:** Verbal stimulus **P:** Pain stimulus **U:** Unresponsive

Exclude: hypoglycemia, hypercapnia or overdose of opiates, benzodiazepines or other sedatives

ACTION

Monitor vital parameters (and continue monitoring)

- Respiratory rate (every 15 minutes)
- Pulse oximetry (continuously)
- Non invasive blood pressure (NIBP) measurement (every 5 min)
- 12-leads ECG (once, repeat if necessary)
- Temperature

19. Approach to respiratory problems

APPROACH

Identify and treat a tension– or open pneumothorax, flail chest, massive hemothorax, and cardiac tamponade IMMEDIATELY

LOOK: cyanosis, respiratory rate, regularity and depth of breathing pattern, use of respiratory muscles, restriction of breathing because of distended abdomen, tight corset/ bandage, check patency of chest drains if present

LISTEN: audible breathing, coughing, can the patient speak in full sentences? Listen to breath sounds

FEEL: chest excursions, subcutaneous emphysema, rib fractures

MEASURE: respiratory rate, peripheral oxygen saturation, take an arterial blood gas to determine PO_2 and PCO_2

TREAT: put the patient upright, start 15L O_2 via a non-rebreathing mask, support breathing if necessary with bag-valve-mask

Generate a DDX and treat accordingly

LOOK FOR:

Signs of respiratory insufficiency (+/- oxygen therapy)

- High respiratory rate ($>20/\text{min}$)
- Use of auxiliary respiratory muscles
- Wants to sit upright, does not want to lie flat
- Increasing restlessness, anxiety or confusion
- Dyspnea, moaning
- Exhaustion, sweating
- Dropping or non-improving oxygen saturation
- $PaO_2 < 8 \text{ kPa}$ and/or $PaCO_2 > 6 \text{ kPa}$

19. Approach to respiratory problems

DDX

COMMON RESPIRATORY PROBLEMS

- **ATELECTASIS**, because of pain or abdominal distension
Can be treated with good pain relief, physiotherapy aimed at deep breathing and coughing up. CPAP can be useful. Antibiotics are only needed in case of an additional infection
- **PNEUMONIA**, patients have an increased risk of developing respiratory failure and ARDS
- **PULMONARY EMBOLISM** associated with DVT
Dyspnea, pleural pain, coughing, hemoptoe tachypnea and tachycardia. Blood gas shows hypoxia and hypocarbia. ECG shows inverted t-waves in anterior chest leads (V1-V6). Consider performing CT pulmonary angiogram.

RISK FACTORS FOR RESPIRATORY PROBLEMS

- history of lung diseases (asthma, COPD, OSAS)
- thoracic and abdominal surgery
- obesity
- elderly
- smoking

20. Approach to circulatory problems

ASSESSMENT

Stop massive external blood loss **IMMEDIATELY using compression or tourniquet**

LOOK: external bleeding, pale gray, clammy patient, assess drain output, blood in gauze/bandage, bed

LISTEN: heart sounds, creptiations (pulmonary edema; congestive heart failure)

FEEL: cold or warm extremities, capillary refill

MEASURE: heart rate, blood pressure, arterial blood gas

TREAT: **STOP** the bleeding, arrange an OR if necessary in consultation with supervisor. If there is **no** suspicion of cardiac decompensation or active blood loss, give a 250 ml fluid bolus and re-evaluate the patient within 30 min.

ASSESSMENT

Signs of circulatory insufficiency

- Pale/ grey, clammy patient
- Increased respiratory rate (>20/min)
- Cold extremities and capillary refill > 2,5 sec.
- Heart rate >100/min (not always case when patient uses beta-blockers or pacemaker)
- Metabolic acidosis: lactate >2 mmol/L and/or BE <-2
- Reduced urine output
- Increasing thirst, anxiety, restlessness or confusion
- Systolic blood pressure <90 mmHg (very late sign)

20. Approach to circulatory problems

Normal vital signs don't rule out a circulatory problem!

Many patients can compensate well for bleeding or sepsis e.g. If hemodynamic deterioration is present **immediate action** must be taken!

DDX

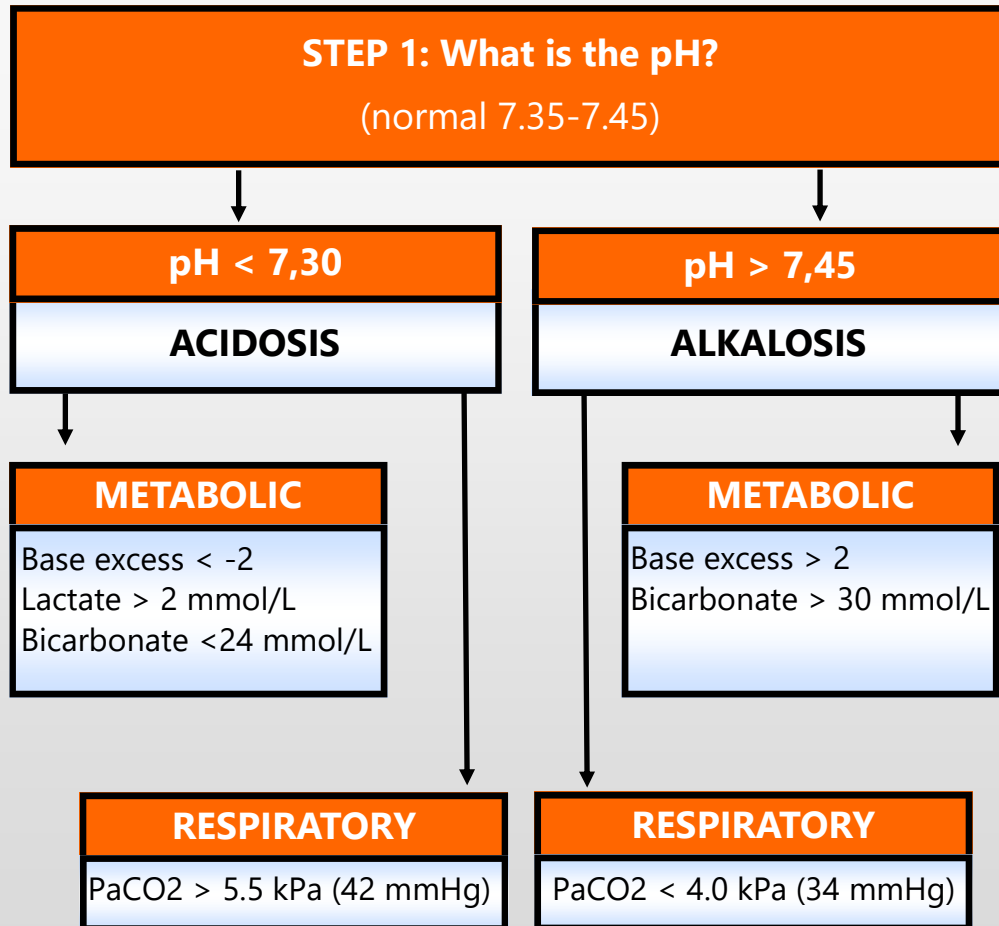
Circulatory insufficiency/ Shock

TYPE	PATHOPHYSIOLOGY	CAUSE
Hypovolemic	Reduced circulatory volume	Loss of blood, plasma, water
Cardiogenic	Reduced pump-function of the heart	Infarction, heart failure, cardiac stunning, arrhythmia
Obstructive	Obstructed venous return	Pulmonary embolism, cardiac tamponade, tension pneumothorax
Distributive	Peripheral vasodilatation	Sepsis, intoxication, neurogenic, anaphylaxis

- **Hypovolemic:** pale or clammy patient with cold extremities
- **Distributive:** vasodilatation, sweating, relatively warm extremities. Relative bradycardia in neurogenic shock (Spinal cord injury above T4)
- **Cardiogenic:** grey patient with cold extremities, signs of pulmonary edema and/or chest pain, ECG abnormalities, after cardiac surgery
- **Obstructive:** distended jugular veins, depends on diagnosis (often wants to sit upright) consider echocardiogram

21. ABG interpretation

THE INTERPRETATION OF AN ARTERIAL BLOOD GAS



Mixed metabolic and respiratory acidosis or alkalosis can also occur (in which case both the respiratory and metabolic values are abnormal)

COMMON CAUSES METABOLIC ACIDOSIS

- Hypovolemia (bleeding, high output fistula, diarrhea)
- Distributive shock (sepsis)
- Cardiogenic shock (myocardial infarction, heart failure, cardiac stun)
- Kidney failure
- Liver failure
- Ketoacidosis
- Convulsions/increased muscle activity
- Intoxication (acetylsalicylic acid, methanol, ethylene glycol)

Patient is often (very) ill, immediate liaison with RRT/ ICU is indicated

21. ABG interpretation

COMMON CAUSES METABOLIC ALKALOSIS

- Loss of acid (loss through nasogastric tube, vomiting)
- Hypokalemia
- Diuretics
- Administration of sodiumbicarbonate

Patient is usually asymptomatic, however, cardiac contractility, coronary and cerebral blood flow can decrease. Patient can hypoventilate to compensate. Convulsions and encephalopathy can occur when $\text{PH} > 7.6$

- Hypoventilation (reduced level of consciousness, sedation, pain)

COMMON CAUSES RESPIRATORY ALKALOSIS

- Hyperventilation (stress, pain, pulmonary embolism)

STEP 2: Gas exchange

P_aO_2 (oxygenation) en P_aCO_2 (ventilation)

THE INTERPRETATION OF AN ARTERIAL BLOOD GAS

Hypoxia $< 10 \text{ kPa}^*$
Normal: $11-14 \text{ kPa}^*$
Hyperoxia $> 15 \text{ kPa}^*$

Hypocapnia: $< 4 \text{ kPa}^*$
Normocapnia: $4.5-5.5 \text{ kPa}^*$
Hypercapnia $> 6 \text{ kPa}^*$

RESPIRATORY FAILURE

TYPE I Isolated hypoxia ($\text{PaO}_2 < 8 \text{ kPa}^*$)
TYPE II Hypoxia and hypercapnia ($\text{PaO}_2 < 8 \text{ kPa}$ en $\text{PaCO}_2 > 7 \text{ kPa}^*$)

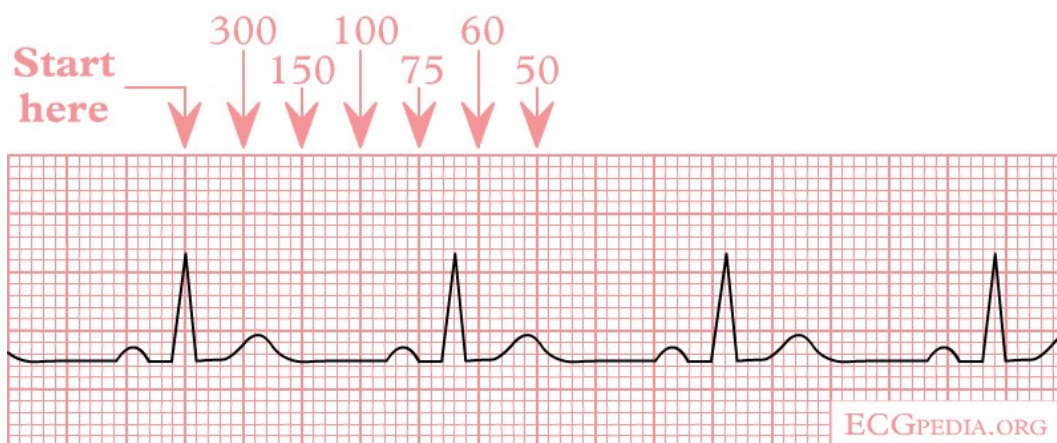
* mmHg = kPa x 7,5

22. ECG

ECG ASSESSMENT

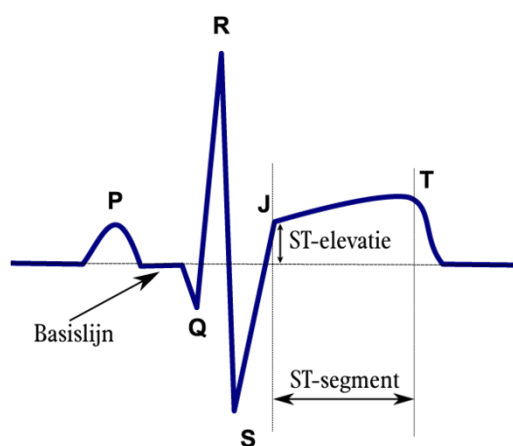
1. Rhythm: P-wave preceding every QRS complex and positive in I,II, aVF?
2. Heart rate
3. Conduction:
 - PR INTERVAL, 0,12-0,2 SEC. (<5 boxes)
 - QRS COMPLEX <0,12 SEC. (<3 boxes)
4. Heart axis:
 - Normal axis: between -30° en 90°
 - Left axis: between -30° en -90°
 - Right axis: between 90° en -180°
 - Extreme axis: between -90° en -180° (rare)
5. P-wave AND QRS-complex AND ST-segment morphology
6. Ischaemia: ST-elevation and T-wave inversion (see box **3**)

HEART RATE



From: ECGPEDIA.ORG

ST-ELEVATION



From: ECGPEDIA.ORG

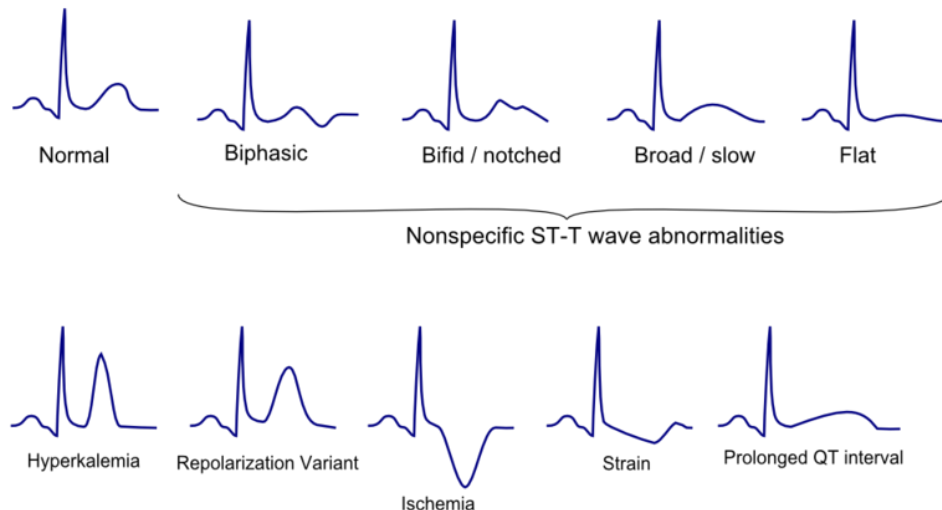
22. ECG

DETAILS

① AV-CONDUCTION DISORDERS

1 st Degree AV-block:	PQ-time > 0,2 sec, each P-wave is followed by a normal QRS complex
2 st Degree AV-block:	Type 1: PQ interval extends with every beat until a QRS complex falls out Type 2: PQ interval regular, random outages of QRS complex
3 st Degree AV-block:	No relationship between P-waves and QRS complex. Rhythm is nodal (40-50/min) QRS narrow (<3 boxes) OR rhythm is ventricular (30-45/min) QRS is wide (>3 boxes)

② T-WAVE MORPHOLOGY



ECGPEDIA.ORG

From: ECGPEDIA.ORG

DETAILS

③ ECG CHANGES IN ISCHAEMIA

Anterior infarct: ST elevation in V₁-V₆
Inferior infarct: ST elevation in II, III, aVF
Lateral infarct: ST elevation in I, aVL, V₅, V₆
Posterior infarct: Isolated ST-depression V₁-V₃
 (difficult to diagnose, ICC cardiology)

This bundle of cognitive aids is developed by the departments of Anesthesiology, Surgery and Intensive Care of the Amsterdam Amsterdam University Medical Centers (AUMC). The design is based (with permission) on the Emergency Manual of the Stanford Anesthesia Cognitive Aid Group: "Emergency Manual: Cognitive aids for perioperative critical events". This CAMDS bundle has been created to match international and Dutch guidelines and the protocols of the Amsterdam UMC. Although the information in this manual has been compiled with the greatest possible care, the authors and the publisher accept no responsibility whatsoever for any typographical errors or other inaccuracies. This bundle can not replace the "Modified Early Warning Score" (MEWS) but is an addition to the MEWS for diagnostic and treatment steps to be undertaken in case of a deteriorating surgical ward patient.

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