



**EMERGENCY
QUICK REFERENCE
GUIDE**

ESA/EBA TASK FORCE PATIENT SAFETY

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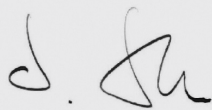
Preface

The ESA and EBA Helsinki Declaration on Patient Safety in Anaesthesiology¹ requires to have protocols available for the management of perioperative complications. Based on the book "The Anaesthetic Crisis Manual"² by David Borshoff and the previous ESA project "OLEH" (Online Electronic Help) by Azriel Perel, the Task Force Patient Safety has developed checklists for various emergencies that appear similar to reference guides used in aviation for in-flight emergencies.

The first draft has been made available on the webpage of the European Society of Anaesthesiology at the end of the year 2012 for open feedback by every ESA member. Taking all the different and very valuable feedbacks into account, these emergency quick reference guidelines have been produced with prudence. Nevertheless, each practitioner is advised to pay careful attention when using these checklists as we do not take responsibility for the consequences out of their application. Furthermore we continue to invite everyone to give us qualified feedback for any possible improvement of these checklists in the future.

These checklists are thought to be a service for the ESA and EBA members and every anaesthetist or national anaesthesia society should feel free to adopt them to their local or national practice.

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- 1 Mellin-Olsen J, Staender S, Whitaker DK, Smith AF. The Helsinki Declaration on Patient Safety in Anaesthesiology. Eur J Anaesthesiol 2010 Jul;27(7):592-7.
- 2 Borshoff D. The Anaesthetic Crisis Manual. Cambridge University Press, Cambridge, UK 2011

CONTENT

Intraoperative Myocardial Ischaemia	1
Anaphylactic Reaction	2
Haemolytic Transfusion Reaction	3
Air Embolism	4
Laryngospasm	5
Malignant Hyperthermia	6
Newborn Life Support	7
Severe Bronchospasm	8
Local Anaesthetic Toxicity	9
Hyperkalaemia	10
Aspiration	11
Severe Bleeding	12
Increased Airway Pressure	13
Differential Diagnosis Hypocapnia / low etCO₂	14
Differential Diagnosis Hypercapnia / high etCO₂	15
Differential Diagnosis Bradycardia	16
Severe Bradycardia	16a
Differential Diagnosis Tachycardia	17
Severe Tachycardia	17a
Differential Diagnosis Hypotension	18
Left Ventricular Shock	18a
Right Ventricular Shock	18b
Differential Diagnosis Hypertension	19
Differential Diagnosis Desaturation / low SpO₂	20

Sign

ECG: ST-Segment depression/elevation, new T-wave inversion, new dysrhythmias

Goal

Reduction in myocardial oxygen consumption and increase in myocardial oxygen delivery

Oxygenation

- Increase FiO₂ 100% (SpO₂ > 94%)
- Correct anaemia.
Check Hb and consider transfusion (aim Hb 7 – 9 g/dl)

Stress Response

- Check depth of anaesthesia (avoid stimulation if possible)
- Sufficient analgesia

Myocardial Perfusion Pressure

- Increase perfusion pressure
Consider Noradrenalin 5 – 10 mcg i.v. if HR > 90/min
Consider Ephedrin 5 mg i.v. if HR < 90/min

Heart Rate

- Titrate to desired heart rate while avoiding hypotension
- Goal 60 – 80 beats/min
Consider Esmolol 0.25 - 0.5 mg/kg i.v. (\pm 50 – 200 mcg/kg/min)
Consider Metoprolol 2.5 mg i.v.

Contractility

- Increase contractility
Consider Dobutamin 2 – 4 mcg/kg/min

Preload

- Decrease preload
Consider sublingual Nitroglycerine (NTG) initially or
NTG infusion 0.5 - 1 mcg/kg/min
Monitor carefully

Volume status

- Avoid hypovolaemia
Consider volume load 20 ml/kg

Consider further actions

- Anticoagulation (Heparin and/or Aspirin)
- HDU/ICU admission
Multi-lead ECG monitoring, invasive monitoring, TEE, 12-lead ECG asap, repeated lab check for troponin, CK, CK-Mb etc.
- Coronary intervention
- Intra-aortal balloon pump (IABP)

Sign:

- Hypotension
- Pulmonary edema
- Bronchospasm (increased insp. pressure, decreased compliance)
- Hypoxia
- Erythema / flush
- Angioedema
- Nausea / vomiting in awake patients

Call for support / inform surgeon**Stop all potential triggering substances**

- e.g. drugs, colloids, blood products, latex products

Full resuscitation (start chest compression if no carotid pulse for → 10 sec)

- **Adrenaline** 1 mcg/kg i.v.
Start adrenaline infusion 0.1 mcg/kg/min titrated to maintain systolic blood pressure at least 90 mmHg
- In Cardiovascular collapse:
Adrenaline 1 mg i.v. ADULT
Adrenaline 10 mcg/kg i.v. CHILD
Consider Vasopressin 2 U i.v. ADULT

Consider endotracheal intubation and FiO2 100%**Increase preload**

- Volume load (min. 20 ml/kg)
- Trendelenburg-Position (leg elevation, head down)

Monitoring

- Place arterial line
Take arterial blood gases

Consider further actions

- Hydrocortisone bolus i.v. or i.m.
 - > 12 years: 200mg
 - 6-12 years: 100mg
 - < 6 years: 50 mg
- H-1-blocker:
 - **Clemastine** 2 mg bolus i.v. or i.m.
 - **Diphenhydramine** bolus i.v. or i.m.
 - <12 years: 1- 2 mg/kg max 50 mg
 - >12 years: 25 – 50 mg max 100mg
- H-2-blocker: **Famotidine** 20 mg i.v.
- Aminophylline bolus up to 5 mg/kg i.v. or i.m.
- Take blood samples for tryptase levels
 - when patient is stabilized
 - after 2 hrs and 24 hrs
- Arrange for allergy testing after one month

Signs in the patient under anaesthesia:

- Hypotension, tachycardia, circulatory instability
- Bronchospasm, wheezing, decreased pulmonary compliance,
- Hypoxia
- Urticaria, edema formation
- Bleeding from infusion sites and membranes
- Dark-coloured urine

Call for support / inform surgeon

Stop transfusion, keep iv-line open (flush with saline)

Full resuscitation (airway, breathing, circulation)

- Adrenaline 1 mcg/kg i.v.
Start adrenaline infusion 0.1 mcg/kg/min titrated to maintain systolic blood pressure at least 90 mmHg
- In Cardiovascular collapse:
Adrenaline 1 mg i.v. ADULT
Adrenaline 10 mcg/kg i.v. CHILD

Consider endotracheal intubation and FiO2 100%

Treat bronchospasm (see reference No.13)

Volume load (min. 20 ml/kg)

Trendelenburg-Position (leg elevation, head down)

Maintain urinary output

- Use diuretics:
Mannitol 25% 0.5 - 1 g/kg i.v.
Furosemide 0.5 mg/kg i.v.

Monitoring

- Place arterial line
Take arterial blood gases

Further actions

- Consider **Methylprednisolone** 1- 3 mg/kg i.v.
- Take care of developing coagulopathy:
 - coagulation lab
 - consult transfusion services/laboratory
- Collect and return all transfusion products
- Check ID of patient & blood documentation
- Take fresh urine and blood samples for analysis

Signs in the patient under anaesthesia:

- Desaturation
- Drop of etCO_2
- Hypotension, tachycardia
- CV collaps
- Raised CVP or distended neck veins
- Bronchospasms, Pulm. edema
- Auscultation: 'Mill wheel' murmur

Risk prone operations:

- In general: surgical site higher than right atrium, e.g.: head down position and pelvic/lower abdomen surgery (Gyn., Urology)
- Laparoscopic surgery
- Surgery in sitting position

Call for support / inform surgeon**Prevent further entrainment of air**

- Flood operative field with saline
- Compress bleeding sites

Tilt table head down and left lateral

- Caution: side supports on table?!
- In CPR: tilt table for operation side lower than level of heart (if possible)

Switch to FiO_2 100% (stop N_2O , if in use)**Relief pneumoperitoneum (if in use)****Cardiac support, avoid hypovolaemia**

- Maintain systemic arterial pressure with vasopressors/inotropic agents
- Increase venous pressure with fluids (20 ml/kg) and vasopressors
- Use RV failure algorithm (18b)

Consider PEEP (controversial)**If central line in place: aspirate****Consider Closed Cardiac Massage**

- Comment: to break up large volumes of air
- Early TEE to rule out other treatable causes of pulmonary embolism

Consider hyperbaric oxygen

- Comment: Usefull up to 6 hrs after the event
Especially in patent foramen ovale (up to 30% of general population)

Call for support / inform surgeon

Ask for Suxamethonium to be prepared

Ask for endotracheal tube to be prepared

Children desaturate quickly

100% Oxygen

Cease all stimulation (surgeon, nurses, orderlies etc.)

Remove any airway device and clear the airway

Jaw thrust and gentle CPAP (20 – 30 cm H2O)

- Guedel airway may be considered
- NO forced inflation attempts. May increase laryngospasm and may lead to aspiration

Consider deepening anaesthesia

- In children extreme caution! Go directly to Suxamethonium

Suxamethonium if SpO2 still decreases

- ADULT: Suxamethonium 1 mg/kg i.v.
- CHILD: Suxamethonium 1.5 mg/kg i.v.
- consider Atropine 0.02 mg/kg i.v. in advance to Suxamethonium

Intubate if necessary

Consider Atropine when going into CV collapse

- ADULT: Atropine 0.5 mg i.v.
- CHILD: Atropine 0.02 mg/kg i.v.

Stomach deflation after event

Clinical Signs:

- Hyperthermia
- Hypercapnia
- Increase etCO₂ without hypoventilation
- Tachycardia
- Sweating
- Masseter-Spasm
- Muscle rigidity

Personal History:

In conjunction with congenital disease (Strabism, Muscle disease e.g. Duchenne)

- Trigger
- Volatile anaesthetics
- Suxamethonium
- Muscle relaxants

Rapid Diagnosis

- Art. blood gases: combined respiratory & metabolic acidosis?
- Core temperature
- Temperature of absorber cannister (not specific)

Differential Diagnosis

- Hypercapnia, tachycardia, sweating
 - **Rebreathing** (Deadspace spec. in children [long tube, extensions...])
 - **Exhausted Absorber**
 - **Low fresh gas flow**
- Metabolic acidosis
 - **Hypothermia, Shock, Sepsis, Hyperchloraemia**
- Hyperthermia
 - **Fever, external heating, Malignant Neuroleptic Syndrome, MAO-inhibitors, Atropine, Hyoscine, Cocain**
- Further differential diagnosis
 - **Hypoventilation, anaphylactic reaction, Pheochromocytoma, thyroid storm, cerebral ischaemia, neuromuscular disease, Capnoperitoneum, Ecstasy**

If in doubt, treat

Stop any trigger

- Switch off volatiles, switch to **Propofol**
- Exchange absorber
- Flush circuit with high flow oxygen

Switch to 100% oxygen

Increase minute ventilation

- Increase minute ventilation at least 3 times
- High fresh gas flow 100% O₂

Dantrolene 2.5 – 8 (max. 10) mg/kg i.v.

- Titrate according to heart rate, rigidity and patient temperature

Cooling

- Stop cooling at < 38.5° C

Treat hyperkalaemia

- 200 ml **Glucose** 20% with 20 U regular **Insulin** over 20 min i.v.
- 10 ml **Calcium chloride** 10% over 10 min i.v.
- **Calcium-Gluconat** (100 mg/kg i.v.)
- Inhalative Beta-2 Agonist (Salbutamol)
- Consider Dialysis

Treat acidosis

- Hyperventilation
- **Sodium-Bicarbonate** (1 mEq/kg, max 50 – 100 mEq)

Monitoring

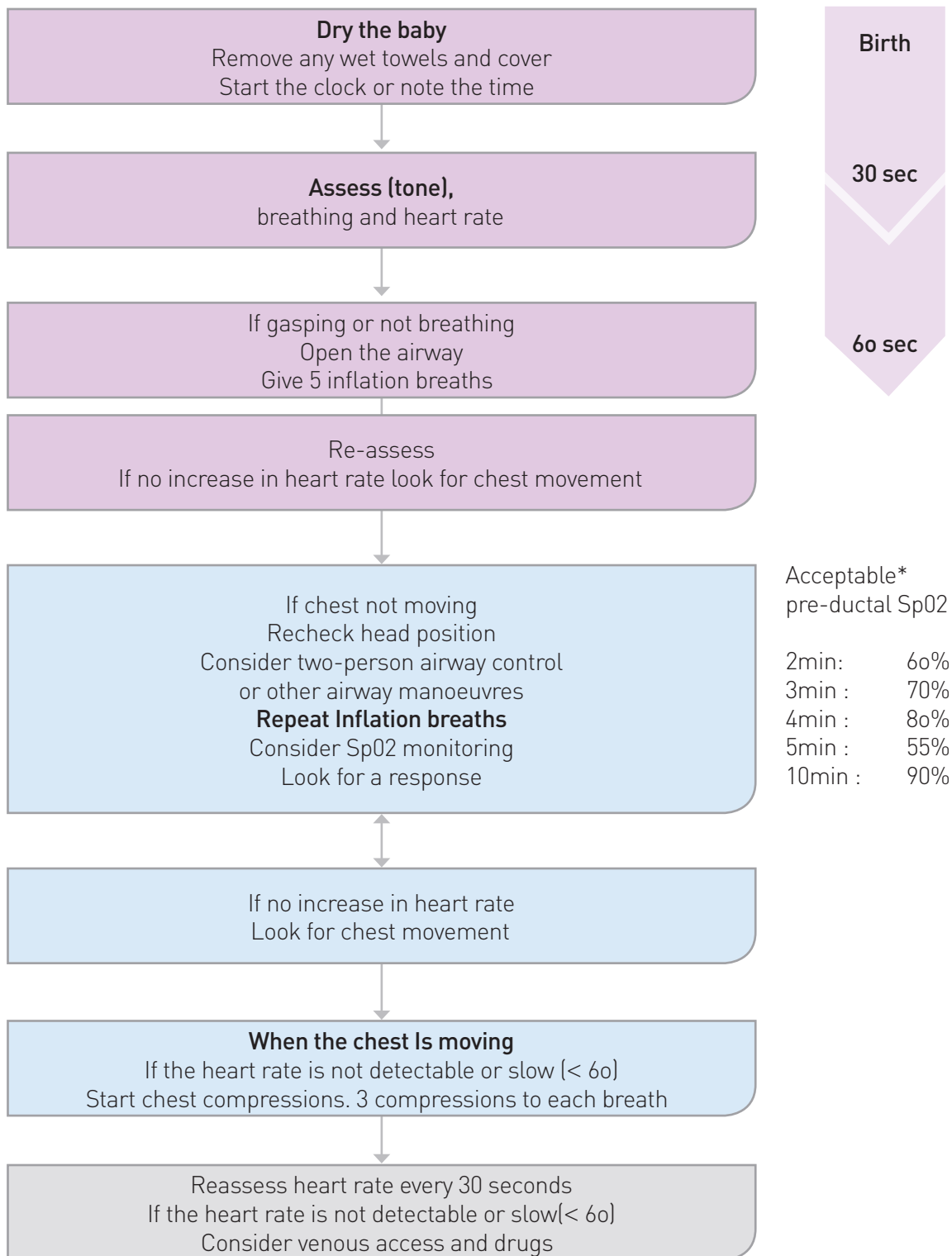
- Core temperature, minimum 2 peripheral lines
- Consider arterial and central line, foley catheter
- Monitor liver- and renal function
- Beware of compartment syndrome

Laboratory values

- Arterial blood gases
- Na, K
- CK

**Your national MH-hotline
Tel.-number:**

At all stages ask: Do you need help?



* www.pediatrics.org/cgi/doi/10.1542/pedS.2009-1510 Copyright European Resuscitation Council - www.erc.edu - 2013/005

Mild Bronchospasm:

- Check airway position
- Deepen anaesthesia
- Use inhalational bronchodilator therapy

Commence manual ventilation, deepen anaesthesia**Check ...**

- Correct airway position
- Capnography
- Airway pressure

Rule out ...

- Severe allergic reaction
- Pneumothorax (previous central line placement ?)
- Left heart failure

Switch to 100% oxygen**2 - 3 puffs Salbutamol**

- Use adaptor for circuit or ETT (endotracheal tube)
- Repeat if required
- Consider Salbutamol i.v. bolus (4 mcg/kg i.v. or s.c.), repeat if necessary

Ventilator settings

- Long expiration phase
- Intermittent disconnection to avoid overinflation of the lungs and allow for CO₂ escape
- Low grade PEEP

Monitor treatment response

- Capnography
- Airway pressure

Consider further actions

- **Adrenaline** bolus 0.1 - 1 mcg/kg i.v. (titrate)
- **Magnesium** 50 mg/kg over 20 min (max. 2 g) i.v.
- **Aminophylline** 5 - 7 mg/kg over 15 min i.v.
- **Hydrocortisone** 1 - 2 mg/kg i.v.
- **S-Ketamine** 0.5 - 1 mg/kg i.v.
- Expanded monitoring with arterial line and serial blood gases
- HDU / ICU admission

Signs:

- Seizures
- Slurred speech
- Numb tongue
- Tinnitus
- Metallic taste
- Higher degree AV-block during/after LA-Injection
- Hypotension
- Wide QRS complex
- Bradycardia deteriorating into PEA and asystole

Stop LA-drug administration

Commence CPR if necessary

- Small doses of epinephrine if LA toxicity is strongly suspected (10 – 100 mcg i.v.)
- Vasopressin is NOT recommended

Treat convulsions (beware of cardiovascular instability)

- Midazolam 0.05 - 0.1 mg/kg (70 kg: 5 - 10 mg)
(20 kg: 1 - 2 mg)
- Thiopentone 1 mg/kg
- Propofol 0.5 - 2 mg/kg (70 kg: 50 - 100 mg)
(20 kg: 20 - 40 mg)

Intralipid 20%

- 1.5 mg/kg bolus i.v. over 1 minute (100 ml in adults) repeat every 5 min up to a max of 3
- Followed by 15 ml/kg/h (1000 ml per h in adults)

Treat cardiac arrhythmias

- Avoid Lidocaine
- Caution with Betablockers (Myocardial depression)
- Consider Amiodarone
- Consider transcutaneous or intravenous pacemaker for symptomatic bradycardic rhythm with pulse

Consider additionally

- H1 blocker: **Diphenhydramin** 50 mg i.v.
- H2 blocker: **Famotidine** 20 mg i.v.
- **Sodium bicarbonate** to maintain pH > 7.25
- Continue CPR for a prolonged period (at least 60 min)
- ECMO

EKG-signs:

- Peaked T-Waves
- Loss of P-Waves
- Prolonged PR-Intervall
- Widened QRS-complex
- Loss of R-Amplitude
- Asystoly

Stop any further K⁺ administration

Hyperventilation (K⁺ shift)

Drugs

- Adult:
 - 10 ml **Calcium chloride** 10% over 10 min i.v.
 - **Sodium bicarbonate** 8.4% 50 ml i.v.
 - 200 ml **Glucose** 20% with 20 U regular Insulin over 20 min i.v.
- Child:
 - **Calcium chloride** 10% 0.2 ml/kg over 10 min i.v.
 - **Glucose** 20% 0.5 g/kg with regular **Insulin** 0.1 U/kg i.v.

Consider further actions

- Nebulized Salbutamol
- Diuretics (Furosemide)
- Potassium-exchange resins (sodium polystyrene sulfonate)
- Hemodialysis

Airway manoeuvres

- Suction oropharynx
- Tilt surgical table „head down“ position
- No cricoid pressure (Sellick) during active vomiting (risk of esophageal rupture)
- Perform laryngoscopy
- Suction pharynx
- Intubate and suction bronchial tree through endotracheal tube BEFORE first manual ventilation

Adjust FiO2 and PEEP according to oxygenation

Suction stomach before emergence

Consider further actions

- Consider bronchoscopy
- In severe aspiration, surgery should only be performed if really urgent
- Consider HDU/ICU admission
- If patient is asymptomatic 2 hrs after event with normal saturation and chest x-ray, ICU admission is not necessary
- NO lavage
- NO steroids
- NO antibiotics

Preparation / Monitoring

- 2 large bore i.v. catheters
- Foley catheter (urine output)
- Temperature-probe
- **Warm Patient actively !**
- Consider arterial and central line (use ultrasound in impaired coagulation)
- Consider rapid-infusion device and cell-salvage system
- Consider anaesthesia induction with already running norepinephrine pump

Laboratory aspects

- Contact and coordinate with blood bank early
- Cross match and antibody screen (Type & screen)
- Blood count (Haemoglobin, haematocrit, thrombocytes)
- Coagulation status (incl. Fibrinogen)
- Art. blood gases (pH, Hb, ionised Ca, Lactate)

Basic therapy

- Keep normothermic (> 36 °C)
- Keep normocalcaemic (1.1 - 1.3 mmol/l, titrate Ca 1 - 2 g i.v.)
- Correct acidosis (keep normovolaemia)
- Keep haematocrit at 21% - 24%
- Aim for MAP 55 - 65 mmHg (severe head trauma MAP 80 - 90 mmHg)

Advanced therapy

- **Fibrinogen** 2 g up to max. 6 g Aim for: Fbg > 2 g/l
- **FFP** init. 15 - 20 ml/kg (~ 2 - 4 bags) Aim for: INR < 1.5
- **Tranexamic acid** 15 mg/kg bolus slowly i.v.
(especially in local hyperfibrinolysis, e.g. uterine atony or abortion!)
- **Thrombocytes:** aim for > 50'000/ul
(Tc > 100'000/ul in severe head trauma)

1. DISTINGUISH**Circuit**

- Respirator settings
- Kinked tubing
- Valve failure
- Failure of high pressure valve
- Failure of O₂-flush

Airway

- Laryngospasm (if not intubated)
- Tube position
- Tube size
- Blocked or kinked tube (patient biting on tube)

Patient

- Bronchospasm
- Laryngospasm (if not intubated)
- Pneumothorax
- Pneumoperitoneum
- Tracheal pathology
 - Foreign body (e.g. chewing gum)
 - Secretions
 - Tumor
- Chest wall rigidity
- Obesity
- Alveolar pathology
 - Oedema
 - Infection
 - ARDS
 - Contusion
 - Fibrosis

Most likely

- Insufficient relaxation
- endotracheal tube position
- Laryngospasm (if not intubated)
- Respirator settings

2. ACTIONS**Check**

- Muscle relaxation
- Depth of anaesthesia
- Capnogram
 - Bronchospasm ?
 - Kinked endotracheal tube ?
- Spirometry
 - Endobronchial intubation ?
 - Kinked endotracheal tube ?
- Tubing circuit
 - Kinked tubing ?
 - Obstructed tubing ?

Do

- Auscultate
- Manually ventilate
- Suction bronchial tree
- Flexible bronchoscopic exam
- If LMA in place consider endotracheal tube

If problems persist

- Review possible patient causes
- Call for assistance
- Repeat checklist together

No etCO₂

- No etCO₂ - NO VENTILATION, NO PATENT AIRWAY !!!
- Oesophageal intubation?
- Disconnection of tubing, complete failure of respirator
- Apnea
- Cardiac arrest

Diminished production of CO₂

- Hypothermia
- Deep anaesthesia
- Hypothyroidism

Enhanced excretion of CO₂

- (Spontaneous) hyperventilation
- Inappropriate ventilator setting

Reduced transport of CO₂ in blood

- Severe hypotension
- Anaphylaxis
- Cardiac arrest
- Pulmonary embolus

Reduced transport of CO₂ in lung

- Endotracheal tube obstruction
- Incorrect airway placement (endobronchial intubation)
- Laryngospasm
- Severe bronchospasm

Sampling dilution

- Disconnection of respirator
- Dilution of sampling gas with room-air
- Gas sampler placed wrong
- High fresh gas flow in circuit

Most likely

- Rule out **MALPLACED AIRWAY** (OESOPHAGEAL)
- Hyperventilation (too high minute ventilation)
- Bronchospasm
- Laryngospasm
- Hypotension

Increased production of CO₂**a. Exogenous:**

- CO₂ insufflation (e.g. laparoscopy)
- Bicarbonate administration
- Re-breathing (valves, Soda lime, fresh gas-flow)

b. Endogenous:

- Painful stimulus
 - Increased body temperature
 - Reperfusion after Tourniquet
 - Sepsis, Malignant Hyperthermia
 - Thyroid storm, Malignant Neuroleptic Syndrome
-

Reduced excretion of CO₂**a. Lungs:**

- Hypoventilation (spont. or respirator settings)
- Bronchospasm, asthma
- COPD (chronic airway disease)

b. Breathing circuit:

- Increased dead space
 - Inadequate fresh gas flow
 - Valve malfunction
 - Incorrect respirator settings
-

Most likely

- Hypoventilation (spontaneous or respirator settings)
- Exhausted soda lime
- Fresh gas flow setting

Primary causes

- Atrioventricular block
- Pacemaker malfunction
- Cardiomyopathy
- Sick sinus syndrome
- Myocarditis
- Pericarditis
- Valvular heart disease
- Pulmonary Hypertension

Secondary causes

- Electrolyte abnormalities
- Antiarrhythmic medication
- Hypothyroidism
- Hypothermia
- Hypervagal
- Increased intracranial pressure
- Tamponade
- Tension pneumothorax

Anaesthetic causes

- Hypoxia
- Volatile agent side effects
- Muscle relaxant side effects
- Narcotic
- Anticholinesterase drugs
- High spinal/ epidural anaesthesia
- Local anaesthetic toxicity
- Hyper- Hypokalaemia
- Vasopressor reflex
- Auto-PEEP
- Malignant Hyperthermia

Most likely

- Drug related
- Hypervagal
- Spinal anaesthesia
- Fitness

Check / rule out

- Pulseoxymetry, Oxymeter, Skin and field blood colour: rule out hypoxia
- Hypovolaemia
- Auto-PEEP
- Gas/air embolism? Thrombo/fat embolism?
- High spinal/epidural
- Tension pneumothorax
- Tamponade
- Other primary, secondary or anaesthetic causes (see Reference Guide 16)

In severe hypotension, poor perfusion, or low etCO₂

- Start CPR
- Improve oxygenation
- Assist ventilation (avoid hyperventilation)
- Volume load (20 ml/kg), repeat if necessary
- Treat potential underlying cause (see check / rule out list above)
- Consider Atropine 0.5 mg i.v. (may repeat up to 3 mg in total)
- Consider Epinephrine 10 to 100 mcg i.v. (may repeat while awaiting pacer)
 - Consider Epinephrine infusion (0.05 – 0.1 mcg/kg/min)
 - Consider Dopamine infusion (2 – 10 mcg/kg/min)
- Consider Isoproterenol 4 mcg i.v. (may repeat while awaiting pacer)
- Consider arterial- and central venous line

If the above is ineffective (use without delay in high-degree block)

- Transcutaneous pacing
- Esophageal pacing
- Transvenous pacing

Consider expert consultation

Acc: Moitra V.K. et al: Can J Anesth/J Can Anesth (2012) 59:586–603

Primary causes

- Cardiomyopathy
- Sick sinus syndrome
- Accessory conduction pathways (Re-entry)
- Myocarditis
- Pericarditis
- Valvular disease
- Congenital heart disease

Secondary causes

- Hypovolaemia
- Anaesthetic depth
- Drugs
- Anxiety
- Pain
- Electrolyte abnormalities
- Cardiac tamponade
- Sepsis
- Thyreotoxicosis
- Lung disease
- Malignant hyperthermia

Most likely

- Anaesthetic depth and surgical stimulation
- Anxiety and pain
- Hypovolaemia

Check / rule out

- Light anaesthesia
- Hypovolaemia
- Auto-PEEP
- Early hypoxia or hypercapnea
- Other primary or secondary causes (see Reference Guide 17)

In severe hypotension or poor perfusion

- Consider synchronized cardioversion

Narrow QRS

- Rhythm **regular**
 - Consider vagal maneuvers
 - Consider **Adenosine** 6 mg i.v. push
if no response give **Adenosine** 12 mg i.v. push
 - If still no conversion:
consider beta blocker (e.g. **Metoprolol** 2.5 mg i.v.) or Ca channel blocker
- Rhythm **irregular**
 - Low ejection fraction (EF) or severe hypotension
consider synchronized cardioversion
consider load **Amiodarone** 150 mg i.v. over 10 min
 - Normal EF or acceptable blood pressure
consider beta blocker (e.g. **Metoprolol** 2.5 mg i.v.) or Ca channel blocker

Wide QRS

- Rhythm **regular**
 - If ventricular tachycardia or uncertain rhythm
consider load **Amiodarone** 150 mg i.v. over 10 min and **Calcium chloride** 1 g i.v.
if no Amiodarone available: **Lidocaine** 1 – 1.5 mg/kg i.v
- Rhythm **irregular**
 - If Torsade-de-Pointes
Consider Magnesium Sulfate 2 g i.v. over 5 min (consider repeat)
 - If pre-excited atrial fibrillation
consider load **Amiodarone** 150 mg i.v. over 10 min

Consider expert consultation

Acc: Moitra V.K. et al: Can J Anesth/J Can Anesth (2012) 59:586–603

Preload Reduction

- Blood loss
- Hypovolaemia
- Decreased venous return (caval vein?)
- Elevated intrathoracic pressure
- Cardiac Tamponade
- Embolism

Reduced Contractility

- Drugs (including volatile agents)
- Ischaemic heart disease
- Cardiomyopathy
- Myocarditis
- Arrhythmia
- Valvular heart disease

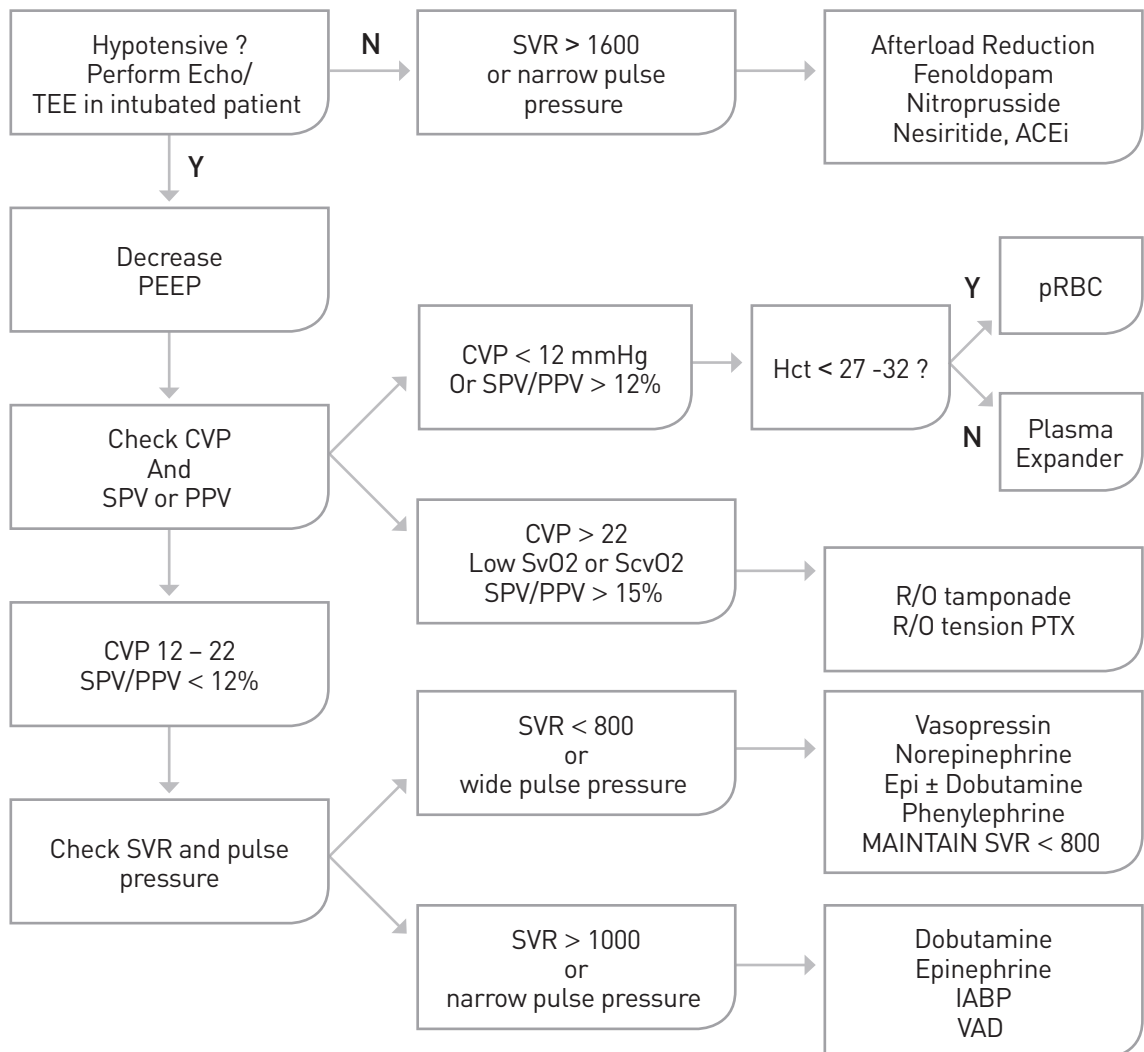
Reduced Systemic Vascular Resistance

- Volatile anaesthetics
- Narcotics
- Vasodilators
- Antihypertensive drugs
- Regional blockade (spinal/epidural)
- Sepsis
- Release of tourniquet
- Anaphylaxis
- Addison's disease
- Thyroid disease

Most likely

- Depth of anaesthesia and volatile anaesthetics
- Narcotics
- Regional blockade (spinal/epidural)
- Hypovolaemia
- Transducer height (invasive monitoring)

18A LEFT VENTRICULAR SHOCK

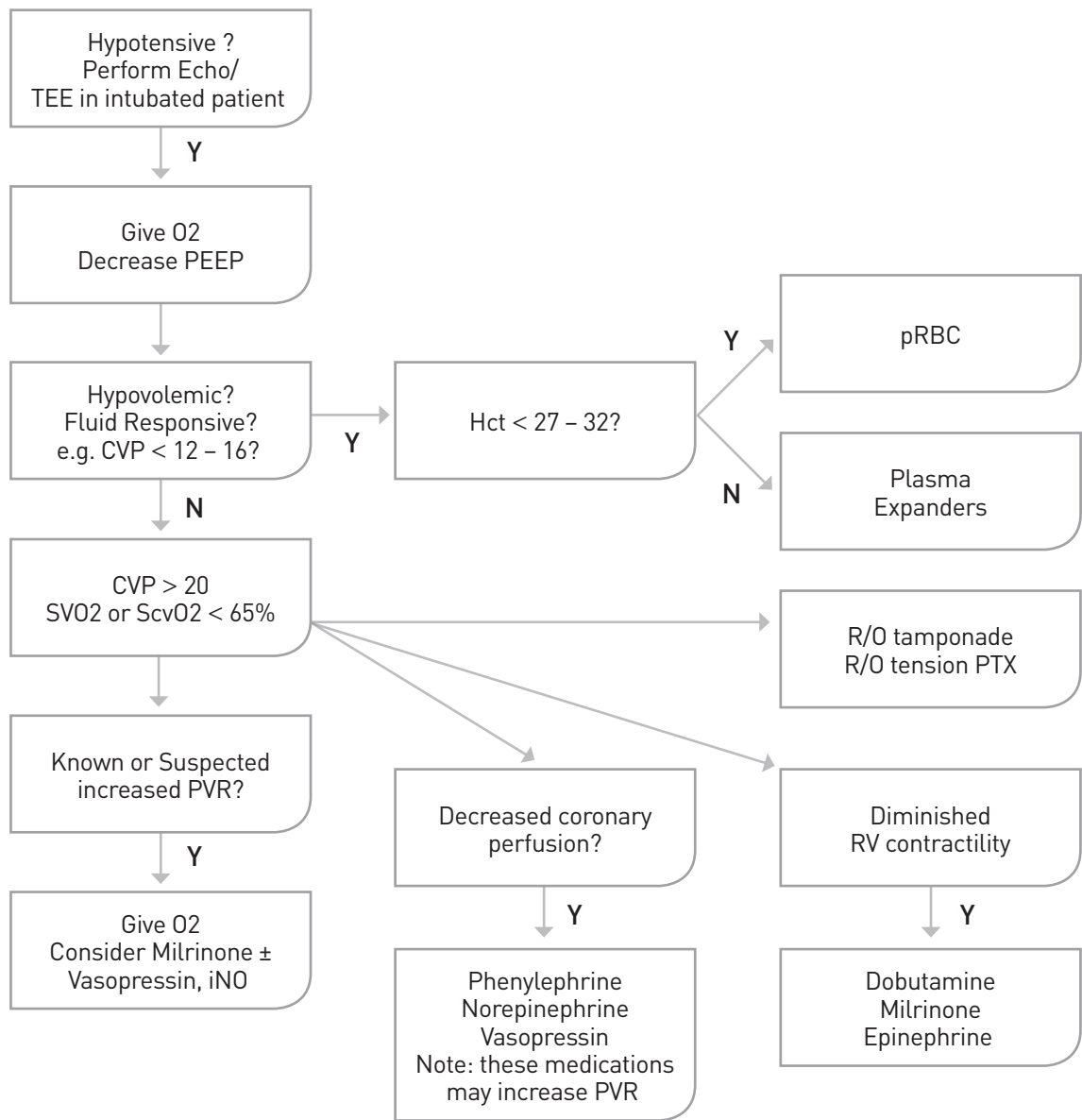


SPV = systolic pressure variation
 SVR = systemic vascular resistance in dyne sec-1cm5m2
 PTX = pneumothorax
 IABP = intraortic balloon pump
 VAD = ventricular assist device
 PEEP = positive end-expiratory pressure
 ACEi = angiotensin-converting enzyme inhibitor

Moitra V.K. et al: Can J Anesth/J Can Anesth [2012] 59:586-603

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18B RIGHT VENTRICULAR SHOCK



TEE = Trans esophageal echo
 CVP = central venous pressure
 pRBC = packed red blood cells
 SVO2 = systemic oxygen consumption
 ScvO2 = central venous oxygen saturation
 PEEP = positive end-expiratory pressure
 iNO = inhaled Nitric oxide
 PVR: pulmonary vascular resistance

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Anaesthesia related causes

- Too light anaesthesia
- Pain
- Hypoxia
- Hypercapnia
- Malignant hyperthermia
- Drugs (Cocain)
- Transducer height (invasive monitoring)

Surgery related causes

- Tourniquet
- Aortic clamping
- Carotid endarterectomy
- Baroreceptor stimulation
- Pneumoperitoneum

Patient related causes

- Essential hypertension
- Rebound-Hypertension (sudden stop betablocker)
- Full bladder
- Pre-eclampsia
- Renal disease
- Pheochromocytoma
- Thyroid storm
- Raised intracranial pressure

Most likely

- Intubation and emergence from anaesthesia
- Inadequate anaesthesia, analgesia
- Pneumoperitoneum
- Drugs
- Essential hypertension

Airway

- Endobronchial intubation
- Airway obstruction
- One lung ventilation
- Laryngospasm
- Aspiration

Breathing / Ventilator

- Low fresh gas flow
- Bronchospasm
- Respirator malfunction/setting
- Circuit obstruction/disconnection
- Pulmonary oedema
- Contusion
- Atelectasis
- Pneumothorax
- Pneumonia
- Sepsis / ARDS

Circulation

- Cardiac arrest
- Cardiac failure
- Anaphylaxis
- Pulmonary embolism
- Hypothermia
- Poor peripheral circulation
- Methaemoglobinaemia (Prilocain, Lidocain, Benzocain)

Most likely

- Probe displacement
- Apnea and hypoventilation
- Tube position
- Laryngospasm
- Bronchospasm