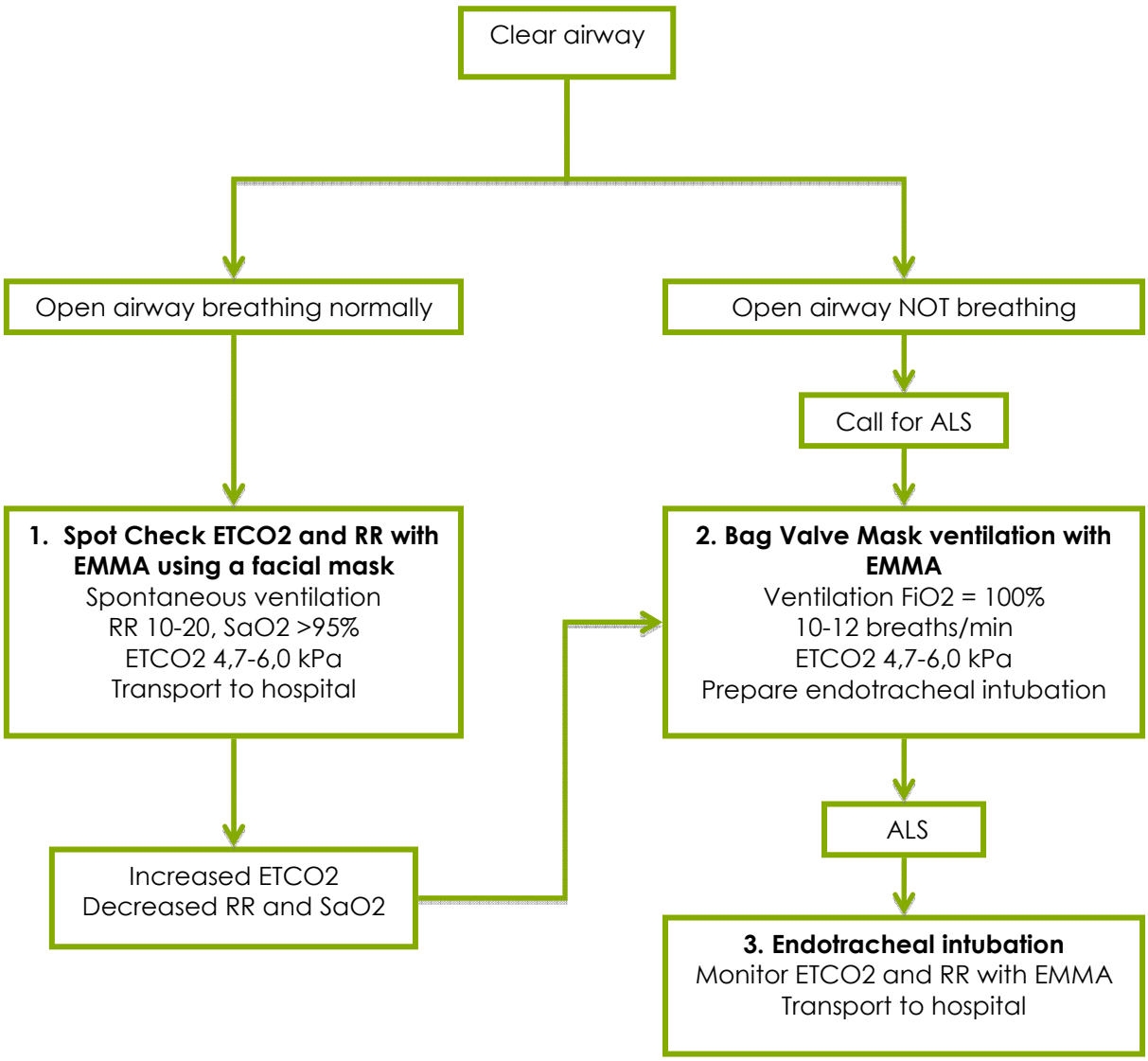
EMMA - Emergency Care Algorithm

The following algorithm describes three applications using the EMMA Capnometer in emergency care: Spot-Checking, Bag Valve Mask ventilation monitoring and Invasive Airway monitoring using an ET-Tube or any Supraglottic Airway Device. By using EMMA you get quantitative measurements of ETCO2 and Respiratory Rate (RR) updated with every breath. The algorithm demonstrates the use of EMMA in emergency care, provided by Emergency Medical Technicians skilled in Basic Life Support (BLS) and/or Advance Life Support (ALS). Followed by this algorithm, a case story for each application is described.



1. Spot Check ETCO2 and RR with EMMA using a facial mask when monitoring ventilatory parameter

Background

A head trauma can result in both primary and secondary brain injury. The primary brain injury refers to the direct trauma to the brain and the secondary brain injury results from complications such as hypoxi, hypo- or hypercapnia. The goal in emergency care of the brain injured patient is to prevent secondary brain injury. Ventilation with 50% oxygen is recommended initially for all unconscious, traumatic brain injury patients with GCS < 8. Hyperventilation is not recommended unless there are signs of brain herniation. If the brain injured patient breathes spontaneously, it can be justified to delay intubation. If the patient's respiratory rate exceeds 30 or respiratory rate is less than 10, intubation should be considered, this also applies to impaired oxygenation. Investigate respiratory rate, ETCO2 and peripheral oxygenation as soon as possible on the brain injured patient.

Case Report

Male, 28 years of age was out on his bicycle and hit by a car. When the BLS ambulance arrives at the scene the patient has a bleeding wound on the head, when asked the patient denies any pain in the head or body. His vital signs show: RR 16, peripheral oxygenation 98%, pulse 94, BP 120/80, GCS 12, amnesia for the time of injury and pupils equal 3mm responsive to light. The patient receives usual care according to PTHLS. After about 15 minutes, the RR increases to 24 and ETCO2 is 3, 9 kPa according to the EMMA Capnometer. GCS decrease to 8, left pupil > than right and not responsive to light. The BLS contacts the dispatch centre for ALS support to perform endotracheal intubation on the patient. Endotracheal intubation was successful and vital signs after intubation resulted in RR 12, and ETCO2 4.5 kPa. During transport to hospital continued RR and ETCO2 monitoring was evaluated to avoid hyper-hypocapnia.

The effect on CO2 levels

A rapid and substantial reduction of PaCO2 leads to a vascular constriction and an increase in PaCO2 resulting in vascular dilatation with a direct effect on the cerebral blood flow (CBF). An increase or decrease in PaCO2 with 1kPa leads to a change in CBF of about 20%. A negative effect on CBF may lead to secondary brain damage.

Clinical significance

An assured and optimum ventilation of the brain injured patient reduces the risk of hypoxia and secondary brain damage.

2. ETCO2 and RR monitoring during bag-valve-mask ventilation

Background

Bag-valve-mask ventilation (BVM) is one of the most common methods of ventilating patients during cardiac- and respiratory arrest. The BVM ventilation is a frequently used procedure for those trained in BLS. However, BVM is thought to be a difficult procedure due to lack of control of successful ventilation. The use of continuous monitoring of ETCO2 and RR could improve the BVM by providing real time continuous feedback about ETCO2 and respiratory rate to the BVM provider.

Case report

A mother found her 15 year old boy in bed, non responsive after a late night. The mother called for an ambulance and when BLS arrived at the scene, the boy's vital signs showed: RR 6, ETCO2 9, 0 kPa, peripheral oxygenation 85, pulse 48, BP 80/50 GCS 8, pupils equal 1, 5 mm responsive to light and P-glucose 5,4 mmol/l. The BLS administered oxygen and started with continuous monitoring of the patients ventilation with a BVM while monitoring the ETCO2 and RR values with the EMMA capnometer. To prevent the risk of aspiration the BLS evaluated the patient's airway by reassessing the patient's vital signs during transport to the hospital, a way to avoid unnecessary supported ventilation.

Arriving at the hospital, the physician in charge at the emergency department administered IV Naloxone and the patient's vital signs showed significant improvement.

Clinical significance

Reduce the risk for aspiration during BVM and continued evaluation of ETCO2 and RR to prevent unnecessary interventions.

3. ETCO2 monitoring with Supraglottic Airways and ET-tubes

Background

Best outcome for patients with cardiac arrest is to begin CPR as soon as possible and to continue until advanced life support is available. The victim's whose heart and breathing have stopped for less than four minutes has an excellent chance for recovery if CPR is administrated immediately. During cardiopulmonary resuscitation carbon dioxide monitoring can be used as an effective tool to assist and evaluating the efficacy of CPR.

Case report

Male, 60 years old is travelling by bus and falls down unresponsive among fellow passengers. A nurse travelling on the same bus identifies a cardiac arrest and calls the emergency services. The nurse starts CPR with 30 compressions and 2 breaths and continues until an ALS provider arrives after 3 minutes. When ALS arrives the man is still in cardiac arrest so they continue administering compressions and breaths. When checking the heart rhythm using an AED, a non shock able rhythm is shown. ALS performs an endotracheal intubation (ETI) and start monitoring ETCO2 using the EMMA Capnometer during CPR.

After ETI and supported ventilation a rapid increase in ETCO2 is monitored. Continued CPR is provided and after a couple of minutes a decreased and stabilized level of ETCO2 is seen.

Eight minutes after successful CPR a shock able rhythm is visible on the AED and 360 joule is delivered which results in a sinus rhythm, BP increases to 80/40, with a still unresponsive and weak cough reflex.

During the transport to hospital the patient's vital signs is monitored and evaluated by using the EMMA Capnometer to reduce the risk of hyper- or hypoventilation on the resuscitated patient.

Clinical significance

Carbon dioxide monitoring can offer an effective tool to evaluate the results of ongoing CPR and to secure adequate ventilation during transport of the resuscitated patient to the hospital.