Airway and Ventilation during CPR

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**Introduction**

The primary components of standard cardiopulmonary resuscitation (CPR) are chest compressions to circulate blood, defibrillation to convert a 'shockable' rhythm into one that will produce a spontaneous circulation, and ventilation of the lungs to enable oxygenation of the blood and removal of carbon dioxide (CO₂). Effective ventilation of the lungs requires a patent airway, while protection of the lungs from aspiration of gastric contents requires reliable separation of the gastrointestinal tract from the airway. Traditionally, the single airway device deemed capable of maintaining airway patency and protecting from aspiration is the tracheal tube. However, the unique status of tracheal intubation is now being challenged. Tracheal intubation is associated with several complications and it is possible that it would be better for healthcare professionals who are not highly skilled in this intervention to use alternative airway devices. After primary cardiac arrest, based mainly on animal data, but also on some low-level human data, ventilation may not be necessary for several minutes. Recent observational clinical studies suggest that chest compression-only CPR by bystanders results in the same or better outcomes than bystander CPR that includes both mouth-to-mouth breathing and chest compressions. There are data indicating that excessive ventilation is harmful during CPR and, possibly, after return of spontaneous circulation. This chapter will focus on the evidence supporting new strategies for management of the airway and ventilation during CPR.

**Regurgitation and Aspiration after Cardiac Arrest**

At the onset of cardiac arrest, the esophageal sphincter pressure decreases rapidly from the normal value of approximately 20 cmH₂O to less than 5 cmH₂O [1], increasing significantly the risk of regurgitation of gastric contents and subsequent aspiration. Regurgitation occurs in about one third of out-of-hospital cardiac arrests, but in at least two thirds of these cases it occurs before arrival of emergency medical services (EMS) personnel [2, 3]. In a study of 182 patients resuscitated after out-of-hospital cardiac arrest, the incidence of regurgitation was 20% [4]. Just under half of these patients had radiological evidence of aspiration; however, 19% of the patients without signs of regurgitation at the scene also had radiological evidence of aspiration. The precise impact of regurgitation and aspiration on long-term survival is uncertain, but in a multivariate logistic analysis regurgitation was associated with a reduced odds ratio (OR) of survival (OR = 0.5 [0.28 – 0.89]) [3].
The Pros and Cons of Tracheal Intubation

It is widely assumed that tracheal intubation improves outcome from cardiac arrest, but this is unproven. There are several reasons why attempted prehospital intubation can be harmful, particularly when undertaken by inexperienced individuals [5]. A recent systematic review of randomized controlled trials (RCTs) comparing tracheal intubation versus alternative airway management in acutely ill and injured patients identified just three trials [6]: Two were RCTs of the Combitube versus tracheal intubation for out-of-hospital cardiac arrest [7, 8], which showed no difference in survival. The third study was a RCT of prehospital tracheal intubation versus management of the airway with a bag-mask in children requiring airway management for cardiac arrest, primary respiratory disorders, and severe injuries [9]. There was no overall benefit of tracheal intubation; on the contrary, of the children requiring airway management for a respiratory problem, those randomized to intubation had a lower survival rate than those in the bag-mask group. The Ontario Prehospital Advanced Life Support (OPALS) study documented no increase in survival to hospital discharge when the skills of tracheal intubation and injection of cardiac drugs were added to an optimized basic life support-automated external defibrillator (BLS-AED) system [10].

Advantages of Tracheal Intubation

The potential benefits of placing a cuffed tube in the trachea during CPR include: Enabling ventilation without interrupting chest compressions [11]; enabling effective ventilation, particularly when lung and/or chest compliance is poor; minimizing gastric inflation and, therefore, the risk of regurgitation; and protection against pulmonary aspiration of gastric contents.

Disadvantages of Tracheal Intubation

A study of first year anesthesiology residents indicated that the learning curve for tracheal intubation in anesthetized patients required about 60 attempts to achieve a 90% success rate [12]. Once competence is achieved, maintaining the skill requires ongoing practice. Seventy-five percent of paramedics in the UK undertake just one or no intubations each year [13]. Several studies indicate that in inexperienced hands the success rate is as low as 50% and complication rates are unacceptably high [5]. The risks of attempting tracheal intubation include: Unrecognized esophageal intubation – 2.9–16.7% in several cardiac arrest studies [5]; unrecognized main stem bronchial intubation; unrecognized dislodgement; and interruption of chest compressions during the procedure. The interruptions in CPR in order to achieve tracheal intubation may negate any theoretical benefits of securing the airway. The interruptions in CPR have been quantified recently in a study of prehospital intubation by paramedics [14]. Using defibrillators that recorded chest compressions, ventilations and end-tidal CO₂, as well as the electrocardiogram (EKG), data on 100 out-of-hospital resuscitation attempts were analyzed to determine the interruptions associated with tracheal intubation attempts. The total duration of the interruptions in CPR associated with tracheal intubation attempts was 110 s (IQR 54–198 s; range 13–446 s) and in 25% the interruptions lasted more than 3 min. Tracheal intubation attempts accounted for almost 25% of all CPR interruptions.