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The Benefits Of Prehospital Advanced Airway Management Techniques In Improving Patient Outcomes

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Abstract

Effective airway management and ventilation are crucial aspects of cardiopulmonary resuscitation (CPR) since they are necessary for delivering oxygen and preventing hypoxic damage, hence improving the likelihood of survival. After considering the advantages and disadvantages, the most effective method is to use a phased strategy. This involves first prioritizing high-quality chest compressions and defibrillation, then improving mask ventilation while getting ready for advanced airway management with a supraglottic airway device. While endotracheal intubation may still be necessary, it has the most significant disadvantages among all advanced airway procedures. Regardless of the stage of airway management, it is essential to regularly check the quality of breathing and chest compressions. Capnography has several benefits and should be used as a standard practice. The issues we must confront include optimizing ventilation systems, aligning ventilation with mechanical chest compression devices, and implementing them in complicated and stressful circumstances. These challenges need joint invention, research, and implementation.

Keywords: *airway management, ventilation, capnography, cardiopulmonary resuscitation, out-of-hospital cardiac arrest, prehospital advanced life support.*

Introduction

The practice of opening the airway and providing insufflations has been a component of resuscitation from ancient times, as documented in the Bible [1]. Recently, the first resuscitation procedure included manipulating the victim's arms to simulate a chest movement resembling respiration. Peter Safar MD later integrated artificial breathing with chest compressions, establishing the foundation of contemporary cardiopulmonary resuscitation [2]. In addition to chest compressions, those without medical training were instructed in mouth-to-mouth ventilation, while medical professionals were instructed in bag-mask ventilation, followed by endotracheal intubation. The original sequence of airway, breathing, and circulation (ABC) during cardiopulmonary resuscitation (CPR) was modified to CAB, with the emphasis on commencing with chest compressions. This adjustment was made since, in the majority of situations, there is still an adequate supply of oxygen in the circulatory system initially. In successive modifications to the guidelines, there has been an increasing emphasis on chest compressions. The ratio of chest compressions to ventilations has progressed from 5:1, to 15:2, and now stands at 30:2. The compression to ventilation ratio has stayed constant in the recent updates of the standards.

Presently, there is a revived focus on airway control, ventilation, and capnography during CPR. Endotracheal intubation is progressively declining as the preferred method for prehospital airway management during CPR, and other ventilation techniques are being investigated. Furthermore, there is a growing recognition of the connection between certain elements of CPR, such as airway control and ventilation, as well as the significance of human factors in clinical performance. Ongoing research focuses on studying the relationship between chest compressions, airway management, and ventilation in cases of out-of-hospital cardiac arrest [3].

Physiology

The primary objectives of CPR are twofold: A) to provide oxygen to the tissues in order to mitigate hypoxic harm, and B) to reinstate the patient's own circulation. During the first moments after cardiac arrest caused by a shockable rhythm, which is also referred to as the electrical phase, the oxygen levels in the blood and tissues, particularly in the heart, are often adequate. As a result, prompt defibrillation is more crucial than providing breathing [4]. After a few minutes, the amount of oxygen decreases and the circulatory phase begins, making ventilations more crucial [5].

Improving CPR techniques will enhance the supply of oxygen and myocardial adenosine triphosphate (ATP), hence increasing the likelihood of effective defibrillation [6]. During hypoxic cardiac arrest, it is crucial to provide ventilations during CPR, since this is the primary therapy for the underlying cause of the arrest.

Despite ongoing disagreement, worldwide standards advocate for the use of ventilations during CPR [7]. Performing CPR with ventilations has been shown to enhance survival rates, in comparison to compression-only CPR [8,9]. Within the context of advanced life support, a higher level of arterial oxygen partial pressure has been linked to a greater likelihood of experiencing return of spontaneous circulation (ROSC) and enhanced chances of survival [10,11]. One additional advantage of ventilation is the elimination of carbon dioxide [12]. after cardiopulmonary resuscitation (CPR), this action aids in counteracting the metabolic acidosis that often arises after cardiac arrest.

However, it is important to note that breathing during CPR may potentially have a physiological disadvantage. while cardiac arrest, none of the physiological processes that facilitate the return of blood to the heart, such as the relaxation of the right ventricle following contraction, the active muscular pump in the legs while walking, and the negative intrathoracic pressure caused by breathing, are operational. Venous return is solely determined by the negative pressure inside the chest, which is created by the recoil of the chest during the decompression phase of chest compressions. Positive pressure ventilations have the potential to increase intrathoracic pressure, which might hinder the return of blood to the heart and so reduce the efficiency of CPR [13]. The similar quandary arises when contemplating the use of positive end-expiratory pressure (PEEP) during cardiopulmonary resuscitation (CPR).

This study specifically examines the methods of managing the airway and providing breathing during resuscitation for adult patients who have cardiac arrest outside of a hospital setting. The goal is to provide assistance to prehospital care providers and provide direction for future research and advancements in this area. This text offers practical advice for doctors working in prehospital emergency treatment, enabling them to effectively save lives in critical situations [14].

Management of the airway

An unobstructed airway is essential for the delivery of oxygen to the lungs. Even if airway blockage is not the major reason for cardiac arrest, a patient experiencing cardiac arrest is unable to keep their airway open owing to the lack of muscular tone and protective reflexes. There is a common occurrence of regurgitation of stomach contents, which leads to contamination of the airway and subsequent aspiration. Hence, airway control is a crucial intervention in all resuscitation efforts.

In clinical practice, the most often used method for managing the airway is a systematic approach that takes into account the resources available and the stage of resuscitation. Non-experts and emergency personnel are instructed to provide mouth-to-mouth resuscitation using the head tilt and chin lift method, along with a face mask if one is accessible. Basic Life Support (BLS) level Emergency Medical Services (EMS) providers commonly employ basic airway maneuvers and self-inflating bags, also known as bag valve masks (BVM). On the other hand, advanced airway management techniques, such as the use of supraglottic airway devices (SADs) and endotracheal intubation, are performed by advanced level providers such as critical care paramedics, nurses, or physicians.

Impact of mechanical chest compression devices

Mechanical chest compression devices might impact breathing during cardiopulmonary resuscitation (CPR), especially when using the 30:2 mode. Both Autopulse® and LUCAS®, which are commonly used mechanical chest compression devices, temporarily halt compressions for duration of 3 seconds after every 30 compressions, in order to administer two ventilations. Following a 3-second interval, compressions are automatically recommenced. The specified period is likely insufficient, since prehospital care providers typically need a median of 5.5 seconds to do two BVM ventilations during manual CPR [15]. Consequently, we anticipate that a considerable proportion of pauses will result in providers being unable to administer two insufflations during the compression pause, or the tidal quantities delivered will be insufficiently modest. This might potentially have an adverse effect on the oxygenation levels and overall result [16,17]. The reduction in the quality of ventilation may surpass the improvement in the quality of chest compression, which might perhaps account for the absence of survival advantages shown in extensive randomized studies [18,19] with mechanical chest compression devices. However, in these studies, the measurement and publication of breathing parameters were not conducted when mechanical compression devices were used [16].

Respiration rate

Adjustments to the ventilation frequency may be made to provide asynchronous ventilation while compressions are underway. An ideal breathing frequency, which ensures adequate oxygenation while minimizing the risk of increased intrathoracic pressure and reduced venous return, is postulated [20]. The current suggested ventilation frequency of 10 ventilations per minute is derived on animal research [21]. Follow-up observational clinical trials shown that increased breathing frequencies were linked to either no deterioration or, in some cases, a beneficial impact on survival [22-24]. According to research, when ventilation rates are between 15 and 20 breaths per minute, the good influence on oxygenation seems to be more significant than the negative effect on cardiac output [12]. Research suggests that increased breathing frequencies may be especially advantageous for extended periods of cardiac arrest [25]. Increasing the rate of breathing also results in greater elimination of carbon dioxide, which helps prevent metabolic acidosis [12].

Tidal volumes

During cardiopulmonary resuscitation (CPR), the tidal volumes should be sufficient for oxygenation, while keeping them as minimal as possible to avoid excessive airway pressure and consequent stomach insufflation in patients who are not intubated. A tidal volume of 1000 ml did not result in a greater partial pressure of arterial oxygen (PaO2) compared to 500 ml [26]. At now, it is advised to use tidal quantities ranging from 500 to 600 ml [7]. CPR education materials often emphasize the need of providing sufficient insufflation to produce a noticeable expansion of the chest. Recent findings indicate that this approach may result in tidal volumes that are too tiny, since tidal volumes of around 380 ml have been shown to generate noticeable chest elevation [27]. Large tidal volumes may be given in practical practice due to the typical capacity of roughly 1.5L in adult BVM devices. In order to mitigate excessive inflation, it has been proposed to use an alternate hold on the bag or to utilize smaller self-inflatable bags, such as pediatric-sized ones [28,29].

Pediatric self-inflating bags provide tidal quantities of around 365 ml, whereas adult self-inflating bags produce tidal amounts of 779 ml. When a pediatric self-inflating bag is employed, both methods result in similar levels of oxygen saturation. However, the employment of both methods leads to reduced airway pressure and less stomach insufflation [30,31]. A recommended duration of 1 second for insufflation is suggested in order to mitigate the drawbacks associated with both short and lengthy insufflation durations [32].

The anesthesiologist role in prehospital resuscitation

Anesthesiologists may play a significant role in several elements of prehospital resuscitation, ranging from operational to strategic levels. However, the extent of their involvement in prehospital treatment varies among countries and prehospital systems [33,34]. Undoubtedly, acquiring supplementary training to provide medical assistance in a prehospital environment is of utmost significance. Including anesthesiologists in prehospital treatment as part of a critical care response tier within an EMS system can enhance the success rate of intubation [35]. Equally significant, however, is their proficiency in making the decision to abstain from intubation [36]. Furthermore, anesthesiologists possess a higher level of skill and knowledge when it comes to managing the airway. This phenomenon was shown in a research where the presence of a prehospital physician, mostly anesthesiologists, was consistently seen as beneficial by ambulance workers, despite no further medical procedures being performed at the site [37]. Prehospital anesthesiologists may enhance patient outcomes by using airway management, implementing additional therapies, and making informed clinical decisions [38,39].

At the managerial level, anesthesiologists have the opportunity to serve as EMS medical directors or engage in collaboration with EMS in areas such as teaching, guidelines, research, and innovation. Prehospital emergency medicine has become an acknowledged specialist in the United Kingdom, recognized by the Royal Colleges of Anaesthetists and Emergency Medicine [40]. Anesthesia societies has the necessary knowledge and skills to create prehospital care recommendations [41].

Summary

Ensuring proper airway control and breathing is crucial in all prehospital resuscitation efforts for out-of-hospital cardiac arrest cases. Ensuring enough oxygenation during CPR is crucial for increasing the chances of survival. However, the most effective approach to achieve optimum oxygenation, in terms of both airway control and breathing method, has yet to be established. Subglottic airway devices (SADs) provide several benefits compared to endotracheal intubation in various situations, and capnography provides more pertinent data than just determining the location of the tube. Additional investigation is required to examine the influence of mechanical chest compression devices on breathing during cardiopulmonary resuscitation (CPR).

It is essential to prioritize enhancing the quality and safety of airway management and ventilation during CPR in order to maximize the chances of survival after cardiac arrest. Emphasizing human factors and ergonomics may enhance performance in the demanding prehospital setting. Anesthesiologists have the ability to significantly enhance clinical practice, education, innovation, and research. We anticipate that a growing number of healthcare experts, both inside and outside the anesthesia sector, will begin and cooperate in research in this stimulating and pertinent area.

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