Advanced Life Support

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Volker Wenzel

The traditional definitions for advanced life support (ALS) techniques generally have been classified as those interventions and procedures that would require physician orders, if not the physicians themselves, to deliver [1–6]. In most countries, these interventions traditionally would include the delivery of intravenous medications and invasive procedures such as endotracheal intubation or intravenous access [4, 5]. While some jurisdictions have allowed nonphysicians, such as ALS-providing paramedics, emergency medical technicians and nurses, to employ these interventions, most of these providers still do so under physician orders, directions and prescribed protocols [7, 8].

In addition to nonphysicians performing these invasive techniques, the traditional lines delineating basic from advanced life support techniques have blurred with the introduction of use of alternative airways by basic life support (BLS) providers, such as emergency medical technicians and the use of automated external defibrillators (AED) by laypersons [9–11]. Also, while not necessarily invasive in all circumstances, techniques for therapeutic hypothermia might be considered advanced techniques [12].

This chapter will deal with concepts that are typically more invasive in nature and requiring physician-level authorisation or performance and most notably invasive airway techniques and intravenous medication administration.

98.1 Evidence for the Effectiveness of Advanced Life Support

Most of the data regarding ALS techniques, particularly in the pre-hospital setting, have come from the laboratory or from in-hospital care experience [2, 3, 5, 6, 12]. Preliminary clinical data do suggest the value of several medications such as vasopressin and amiodarone in the pre-hospital setting [13–15]. However, to date,

V. Wenzel
Department of Anesthesiology and Critical Care Medicine, Innsbruck Medical University, Anichstrasse 35, Innsbruck 35, 6020, Austria
e-mail: volker.wenzel@uki.at

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there are no explicit clinical trials to prove their absolute value on a one-by-one basis [2, 3, 6]. Many investigators have even questioned their use altogether. In fact, there is no clinical evidence to prove positive effects of any ALS drug on long-term survival after cardiac arrest. Even time-honoured interventions such as endotracheal intubation have been questioned, particularly in paediatric resuscitation [16]. It has been recognised that initial training combined with current clinical experience affects success of a given airway intervention more than the airway device itself. Unfortunately, there are many reports where nonphysician and physician rescuers manoeuvred themselves into adverse airway management situations that they were subsequently not able to master, with substantial morbidity and mortality in turn. Thus, it has to be understood by rescuers that if they are unable to give up on unsuccessful intubation attempts which in turn induces or prolongs hypoxia, patients do not die because of absent intubation. They die because of hypoxia if no assisted ventilation is being tried [17]. More relevant to this discussion is that it has become more and more evident that ALS interventions are still of very little value, if they are of any value at all, if BLS is not provided immediately at the scene by bystanders be they lay or professional [18–20] (Chaps. 90 and 91).

Nevertheless, there is some evolving suggestion that certain ALS interventions, while extremely effective in the laboratory, have not demonstrated to be effective in the clinical setting [21–23] perhaps because of confounding variables such as uncontrolled and overzealous ventilatory techniques during the trials [24–27]. It has also been made clear that some aspects of ALS must work, considering the number of survivors among out-of-hospital cardiac arrest patients who do not present with ventricular fibrillation (VT) and never receive defibrillatory countershocks [2, 13, 28]. Since these patients do not respond to BLS and are resuscitated after ALS interventions, some aspect of ALS techniques apparently are effective. What is not clear is the specific intervention. However, it needs to be acknowledged that with the growing presence of automatic external defibrillators, occurrence of VF has decreased, and occurrence of asystole has increased by the time professional rescuers arrive on the scene. Thus, rescuers need to understand that the degree of underlying ischemia may determine long-term outcome more than the ALS intervention itself [29].

98.2 Specific Indications for Advanced Life Support in Drowning Incidents

The indications for ALS techniques for drowning events are even less supported than they are for standard cardiac arrests [18–20]. However, the studies indicating BLS as the rate-limiting step in drowning resuscitation do not preclude the need for ALS. Although most survivors usually respond after BLS, particularly children, many survivors still receive ALS techniques following initial resuscitation. It is therefore assumed that such supportive care is worthwhile, especially as long-term outcome is extremely difficult to predict at the moment resuscitation has to start [30]. In fact, there may be laboratory indications that vasopressin [13] may be somewhat effective in hypothermic states, a common complication of drowning events. However, the combination of vasopressin in hypothermia plus drowning has never been tested. Again, the best specific interventions are not clear and therefore, until proven otherwise, current ALS techniques for typical cardiac arrest are recommended [4, 5].

There are some caveats about such recommendations to follow techniques advised for standard cardiac arrest techniques. Drowning is often associated with hypothermia and sometimes with associated trauma and shock conditions, meaning that even standard rates of ventilation could be harmful, and so caution is warranted not to overzealously ventilate even though drowning is a primary respiratory event [26, 27, 31]. The main concern is that positive pressure breaths, and continuous positive pressure in particular, can inhibit venous return and significantly compromise cardiac output and coronary perfusion [26, 27, 31]. These effects are exacerbated with obstructive lung disease, reactive airways, hypovolaemia and severe circulatory compromise [26].

The main issue to be considered is the appropriate tidal volume. In general, in the resuscitative phase of a drowning event, tidal volumes in the realm of at least 10 ml/kg are probably useful with placement of an endotracheal tube and no application of positive end-expiratory pressure (PEEP). The pulmonary presentation of drowning in terms of chest röntgenogram, arterial blood gases and response to PEEP may resemble acute respiratory distress syndrome (ARDS). Therefore, tidal volumes of 6–7 ml/kg may be advocated by some under these circumstances because of recent relevant studies of tidal volumes in ARDS patients [32, 33]. However, such studies were performed in patients in a post-resuscitation phase who had diffuse inflammatory lung disease with heterogeneous distribution and who, for the most part, were also being ventilated with levels of PEEP above 10 cm H_2O. Therefore, such restrained tidal volumes may not be as applicable in the out-of-hospital resuscitative phase of the drowning scenario in which surfactant loss and other physiological sequelae may make alveolar recruitment more difficult, particularly in the absence of PEEP.

In other words, in the resuscitative phase, there are no studies that would confirm the need for a low tidal volume approach, especially since the pathophysiology of drowning is probably very different from the typical ARDS case and has a different natural history and response to therapy [34]. Low levels of PEEP may be useful in the field if the patient is haemodynamically stable and can tolerate the application of PEEP. These are situation in which, in lieu of other invasive monitoring, there are no obvious effects on blood pressure and pulses. In turn, if pulse oximetry is operable because of good circulation and warmed extremities, tidal volumes may be reduced accordingly if saturation is maintained above 95 %.

The main concern in terms of ventilatory techniques is the situation of shock or circulatory arrest in which PEEP would be relatively contraindicated because of the adverse effects on cardiac output and yet oxygenation is still paramount. Tidal volumes greater than 10 ml/kg and much slower rates would likely be the best recommendations at this time, especially in the face of potential hypothermia in which ventilatory rates should be infrequent.

Conclusion

The evidence for ALS in drowning resuscitation is obviously limited, and empiric at best, yet there are promising studies in the laboratory and, preliminary results in the clinical pre-hospital setting, particularly in terms of vasoactive drugs. Limited rewarming and controlled hypothermia may be of value. The complicated issue of tidal volumes, PEEP application and respiratory rates in this unique resuscitative situation deserves focus considering that oxygenation is the primary problem in drowning events [35, 36]. Unfortunately, drowning is an academic pathophysiology with little or even absent industrial or pharmaceutical interest, thus limiting support to academic funders. Further, with all limitations and bureaucracy posed on clinical trials by guidelines for good clinical practice and national laws, significant research progress is unfortunately unlikely despite about 450,000 drowning casualties annually.

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