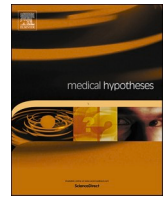




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## Barrier resuscitation by lay rescuers during COVID-19 pandemic

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### ARTICLE INFO

#### Keywords:

Airway control  
Basic cardiac life support  
Mouth-to-mouth resuscitation  
Resuscitation  
Cardiopulmonary

### ABSTRACT

Aerosols generated from chest compressions and ventilation attempts in patients with cardiac arrest may cause airborne infections. Accordingly, the interim international resuscitation guidelines have restricted basic life support by lay rescuers to compression only and the use of an automated external defibrillator during the COVID-19 pandemic. Although these measures may diminish the risk of infection for laypersons, the missing respiratory support can be detrimental for patients with hypoxia-related cardiac arrest. To overcome this shortcoming we want to introduce a special tool that allows ventilation during barrier resuscitation by laypersons. We hypothesize that the application of a device made of a polyvinyl chloride shield with a centrally installed S-shaped ventilation pipe with integrated filter can provide adequate ventilation while concurrently protecting patient and rescuer from airborne agents. Aerosols from air leakage are removed by adhesion and drainage below the barrier. No specific training other than basic life support is needed. We suggest that a tool of this kind be considered essential equipment and stored together with disposable gloves in public access locations.

### Introduction

Presumably, the current pandemic involving severe acute respiratory syndrome-associated corona virus 2 (SARS-CoV-2) will have lasting effects on basic life support and put an end to mouth-to-mouth ventilation as performed until now. This applies to both on-site performance and training [1]. Mouth-to-mouth ventilation has always been a critical issue in cardiopulmonary resuscitation (CPR). On the one hand, it means overcoming disgust and revulsion. On the other hand, the brain has limited tolerance for hypoxia, but its oxygen demand is a multiple of that of other organs of equal tissue mass. Reluctance to perform mouth-to-mouth ventilation is one of the major reasons for low bystander-initiated CPR [2]. Baldi et al. reported that only one-third of lay rescuers is willing to perform mouth-to-mouth ventilation during CPR of an unknown cardiac arrest victim compared to almost 90 per cent when the victim is known [2]. The updated interim international resuscitation guidelines have restricted basic life support by lay rescuers to compression only and the use of an automated external defibrillator during the COVID-19 pandemic [3]. Although chest compression-only CPR for lay rescuers was associated with an increase in the incidence of survival with favorable neurological outcome out-of-hospital cardiac arrests (OHCA) of cardiac origin [4], ventilation is particularly important in cardiac arrest of non-cardiac origin and in children, where most

cardiac arrest cases from hypoxia occur [5,6].

Currently, the risk of contracting an airborne infection from patients or rescuers has gained maximum public attention. Rescuer safety is vital and claims central importance in the interim guidelines for resuscitation [3]. However, restriction of basic life support to compression only and the use of an automated external defibrillator (AED) does not completely eliminate the risk of infection. There is an urgent need for new approaches and further developments.

We would like to present a tool that has the potential to increase safety for both rescuer and patient during basic life support. The tool is made of an S-shaped ventilation pipe inserted in the center of a 120 × 120 cm polyvinyl chloride (PVC) shield. The design of the pipe was inspired by that of the previous Safar tube [7]. The shield serves to blanket the patient in order to diminish the risk of contamination from aerosols, vomitus, blood and body secretions.

### Hypothesis

We hypothesize that the application of a device made of a PVC shield and a centrally installed S-shaped ventilation pipe with integrated filter can provide adequate ventilation during CPR (Fig. 1). We further hypothesize that this tool can diminish potential contamination from aerosols, vomitus, blood and body secretions and protect patient and

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<https://doi.org/10.1016/j.mehy.2021.110648>

Received 26 February 2021; Received in revised form 28 June 2021; Accepted 27 July 2021

Available online 29 July 2021

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**Fig. 1.** Ventilation with Safar Ventilation Foil (SaVe Foil): S-shaped ventilation pipe made of two medium sized Guedel tubes and VT-30 Pediatric Neonatal Electrostatic Filter.

rescuer from airborne agents by removing aerosols from air leakage by adhesion and drainage below the barrier. We suggest that a tool of this kind be considered essential equipment and stored together with disposable gloves in AED public access locations.

The hypothesis differs from current thinking as the interim international resuscitation guidelines have restricted basic life support by lay rescuers to compression only and the use of an automated external defibrillator during the COVID-19 pandemic [3]. There was an increase in OHCA in spring 2020 with a significant reduction in survival related to the pandemic in Northern Italy [8]. Correspondingly, a transient two-fold increase in OHCA incidence, coupled with a reduction in survival, was observed during the same period in Paris [9]. The authors reported a higher rate of OHCA at home, less common bystander CPR, less frequent shockable rhythms, and longer EMS arrival times [8,9].

The scientific logic of the hypothesis is based on:

- 1) the known practicability of airway management with the Safar tube [7],
- 2) the potential of PVC to diminish aerosols by adhesion and drainage [10,11],
- 3) the efficiency of filters to protect from airborne infections [12].

### Evaluation of the hypothesis

Evidence in support:

#### 1) Low cost

We constructed a preliminary model composed of a 120 × 120 cm PVC shield and a centrally installed S-shaped ventilation pipe with integrated filter for bystander CPR. The device is made of a plasticized PVC shield (d50 universalpresenning; JUFOL GmbH, Krumbacher Str. 9, D-86154, Augsburg, Germany) combined with two Guedel airways, size 3 (Rüsch, Teleflex Medical, Dublin Rd, Westmeath, Ireland), and a VT-30 Pediatric Neonatal Electrostatic Filter (HME VT-30; Covidien 15 Hampshire Street, Mansfield, Massachusetts, USA).

#### 2) Applicability

Our preliminary model is suitable for patients from school age to adulthood.

#### 3) Practicability

The device is predestined for bystander use in stressful CPR situations. The tool appears completely symmetrical in design, balanced by

the square PVC barrier and the S-curved ventilation tube. Thus, the device can be applied easily from both ends without complicated adjustment. Despite its symmetry the two ends of the Safar tube should be marked with different colors to indicate the exposed surface. With the patient in a supine position the foil is fanned out over the face. Then the head is tilted backwards sufficiently to open the mouth and the upper airway [13,14]. Now the tube below the shield is inserted into the patient's mouth right side up to avoid trauma to the soft tissues [15]. Ideally, two drawings printed on the foil could serve to guide handling. One would show that the curve of the inserted tube should follow the roof of the mouth. The other would indicate how to seal oral and nasal openings. The technique is simple. One hand applies a nose pinch with thumb and index finger to seal the nostrils. The other hand slightly presses the patient's lips against the ventilation pipe below the filter and tightens the foil to the skin by exerting gentle laminar pressure.

#### 4) Mouth-to-pipe ventilation

The technique of ventilation from mouth-to-pipe resembles mouth-to-mouth ventilation in children and adults. The amount of inhaled air is sufficient when the chest curvature or the epigastric region moves gently up and down with ventilation. No specific training other than basic life support is needed.

Evidence against the hypothesis

#### 1) Limited accessibility

Even when stored together with disposable gloves and AED in public access locations, accessibility is limited to lay rescuers. Only when an AED is within reach would barrier resuscitation be practical right from the start.

#### 2) Tube size

Only one tube size is provided; it corresponds to medium size Guedel tubes. This means the device cannot serve patients of pre-school age or younger. Thus, in toddlers and babies the mouth-to-mouth ventilation technique should be applied whenever it appears reasonable to bystanders.

#### 3) Insertion technique

The insertion technique is restricted to the pediatric version with the tube inserted into the patient's mouth right side up following the roof of the mouth.

### Empirical data

We tested the practicability of the device on a manikin (SimMan Essential; Laerdal Medical GmbH, Operring 1, 1010 Vienna, Austria). Despite the small size of the filter, resistance to ventilating adult tidal volumes was low when eight ventilation attempts per minute were performed in a preliminary test (mean tidal volume: 645.7 ml; range: 633 – 667 ml). While it was difficult to seal the mouth when using the original Safar tube, the combination of tube and foil made it rather easy to seal oral and nasal openings. Amazingly, even the stiff oral opening of the manikin was successfully sealed by pressing the foil against the perioral surface (Fig. 2).

Our hypothesis should be tested in an experimental setting. Ease of handling could be assessed with volunteers applying the foil during CPR training on a manikin. Comparison between SaVe foil and a pocket mask inserted into a PVC foil would be worth testing. Nevertheless, analysis of the potential protection from infection is difficult. Furthermore, the feasibility of the device can be assessed only on-site in real emergencies.



**Fig. 2.** Ventilation with Safar Ventilation Foil (SaVe Foil): A 120 × 120 cm polyvinyl chloride shield with the inserted centrally installed S-shaped ventilation pipe prior to mouth-to-pipe ventilation.

### Consequences of the hypothesis and discussion

There is a need for ventilation during basic life support in cases with hypoxia-induced cardiac arrest [13]. Ventilation is particularly important in pediatric CPR where hypoxia is the most common cause of cardiac arrest [5,6]. Unfortunately, mouth-to-mouth ventilation cannot even be practiced in hands-on training without endangering the health of trainees [1].

The device is predestined for bystander use in stressful CPR situations. It is suitable for patients from school age to adulthood and can be applied easily without complicated adjustment. Increasing safety and motivation in lay rescuers is vital as bystander CPR and public location of emergencies were reported to be independent prognostic factors for survival to hospital discharge in OHCA patients [16]. If the device is stored together with AEDs in public locations the device would be on hand in approximately 5% to 10% of cases [17].

### Sources of funding

Institutional.

### Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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