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Clinical paper

Association of advanced airway device with chest compression fraction during out-of-hospital cardiopulmonary arrest☆

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ABSTRACT

Background: Select Emergency Medical Services (EMS) practitioners substitute endotracheal intubation (ETI) with supraglottic airway (SGA) insertion to minimize CPR chest compression interruptions, but the resulting effects upon chest compression fraction (CCF) are unknown. We sought to determine the differences in CCF between adult out-of-hospital cardiac arrest (OHCA) receiving ETI and those receiving SGA.

Methods: We studied adult, non-traumatic OHCA patients enrolled in the Resuscitation Outcomes Consortium (ROC) Prehospital Resuscitation using an Impedance valve and an Early vs. Delayed analysis (PRIMED) trial. Chest compressions were measured using compression or thoracic impedance sensors. We limited the analysis to those receiving ETI or SGA (Combitube, King Laryngeal Tube, or Laryngeal Mask Airway) and >2 min of chest compression data before and after airway insertion. We compared CCF between ETI and SGA before and after airway insertion, adjusting for age, sex, witnessed arrest, bystander CPR, shockable initial rhythm, public location, PRIMED trial arm, and regional ROC center. We also compared the change in CCF for each airway technique.

Results: Of 14,955 patients enrolled in the ROC PRIMED trial, we analyzed 2767 cases, including 2051 ETI, 671 SGA, and 45 both. Among subjects in this investigation the mean age was 66.4 years with a male predominace, 46% with witnessed event, 37% receiving bystander CPR, and 22% presenting with an initially shockable rhythm. Pre- and post-airway CCF was higher for SGA than ETI (SGA pre-airway CCF 73.2% [95%CI: 71.6–74.7%] vs. ETI 70.6% [95%CI: 69.7–71.5%]; post-airway 76.7% [95%CI: 75.2–78.1%] vs. 72.4% [95%CI: 71.5–73.3%]). After adjusting for potential confounders, these significant changes persisted (pre-airway difference 2.2% favoring SGA, p-value = 0.046; post-airway 3.4% favoring SGA, $p = 0.001$).

Conclusion: In patients with OHCA, we detected a slightly higher rate of CCF in patients for whom a SGA was inserted, both before and after insertion. However, the actual differences were so small, that in the context of this observational, secondary analysis, it is unclear if this represents a clinically significant difference.

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Background

Out-of-Hospital Cardiac Arrest (OHCA) is a major public health problem affecting greater than 325,000 persons annually in the United States with a mortality rate approaching 90%.[1] Current OHCA guidelines emphasize minimizing cardiopulmonary resuscitation (CPR) chest compression interruptions to maintain a chest compression fraction (CCF—the amount of time with active chest compressions) greater than 80%.[2]

The choice of advanced airway inserted during resuscitation has been identified as an opportunity to improve CCF. Prior literature has demonstrated that endotracheal intubation (ETI) performed during pulselessness may cause over 90 s of chest compression interruptions.[3] Though initially designed as a rescue airway in the event of failed ETI in the operating room, SGA insertion has rapidly gained favor in the prehospital environment due to its rapid, technically simpler technique for insertion. Some EMS practitioners favor primary SGA over primary ETI to avoid chest compression interruptions. However, there have been few direct evaluations of the effect of advanced airway devices upon CCF.

The objective of this study was to evaluate the impact of advanced airway management device type upon CCF in OHCA enrolled in the Resuscitation Outcomes Consortium (ROC) Prehospital Resuscitation using an Impedance valve and an Early vs. Delayed analysis (PRIMED) trial.

Methods

Study design

This study was a secondary analysis of data prospectively collected as part of the ROC PRIMED trial. The ROC PRIMED study was conducted using Exception from Informed Consent (EFIC) under United States regulations (21 CFR 50.24) and the Canadian Tri-Council Policy Statement: Ethical Conduct for Research Involving Humans. Additional approvals were sought and obtained from the US Food and Drug Administration (FDA) and Health Canada, as well as institutional review boards and research ethics boards at the respective institutions where the research was conducted.

Study setting

ROC is a multi-center research network in North America conducting out-of-hospital and clinical intervention trials focused upon cardiac arrest and traumatic injury. ROC consists of more than 250 EMS agencies spread among 10 communities: Seattle/King County, WA; San Diego, CA; Milwaukee, WI; Pittsburgh, PA; Portland, OR; Dallas, TX; Birmingham, AL; Toronto, Ontario; Ottawa, Ontario; and British Columbia. Of these, 150 EMS agencies participated in the study. Centralized data collection and management was provided by the data coordinating center in Seattle.

PRIMED sought to compare two interventions employing a factorial design: (1) a strategy of early (immediate) verses late (~180 s) initial ECG analysis and subsequent defibrillation as appropriate and (2) the use of an impedance threshold device (ITD) vs. a sham device. Both arms of the ROC PRIMED study were halted at an interim analysis for futility, as there was no detectable difference in outcomes among participants in any arm.[4,5]

Study population

This analysis consisted of patients enrolled in the ROC PRIMED trial (1) receiving successful ETI or SGA insertion and (2) with CPR process data available for at least 2 min immediately before and immediately after advanced airway insertion. SGA devices used by EMS agencies in the ROC PRIMED trial included King Laryngeal Tube (Ambu, Inc., Noblesville, IN), Combitube (Covidien, Inc., Mansfield, MA), and Laryngeal Mask Airway (LMA North America, San Diego, CA). Selection of ETI vs SGA was at provider discretion or local medical direction and not dictated by study protocol (ROC PRIMED or other ROC investigation). CPR process data was collected by either changes in thoracic impedance recorded from external defibrillation electrodes or via an accelerometer interface between the rescuer and the patient's chest, depending on the defibrillator manufacturer used (Zoll Medical Corporation, Chelmsford, MA; Physio-Control, Redmond, WA; Royal Phillips, Amsterdam, The Netherlands). The authors chose to exclude patients enrolled at the Seattle/King County site *a pirori* as no SGA devices used during the study period.

At the time of the PRIMED trial, only two sites allowed BLS personnel to perform advanced airway maneuvers. At the Ottawa site, three agencies allowed BLS providers to perform King LT insertion. At the San Diego site, BLS providers were also allowed to use the King LT, but the majority of OHCA received initial advanced airway care from ALS providers.

Methods of measurement

The PRIMED trial followed uniform data collection and reporting guidelines consistent with Utstein standards.[6] Prehospital care provided was described on either electronic or paper care reports, including details of airway and resuscitation management. Each coordinating center was responsible for determining outcomes and complications from prehospital, receiving hospital, and publically available death records as appropriate.

In addition, digital CPR process recordings of the two minute intervals immediately before and after documented advanced airway insertion were evaluated for the presence and frequency of chest compressions. (Fig. 1) CCF was defined as the proportion of resuscitation time without spontaneous circulation during which CPR was administered, averaged over the 2 min pre- or post-airway period in question.

Outcome measures

The primary outcome of this analysis was chest compression fraction (CCF), defined as the portion of each elapsed treatment time with active chest compressions. The method of CPR performance (i.e., 30:2 or continuous chest compressions) was left to local agencies. Consistent with previous PRIMED sub-studies, active chest compressions were defined as any measured attempt to compress the chest, regardless of quality. Any pause of greater than 2 s (the smallest interval measureable by the software packages used) was considered an interruption for the purposes of calculating CCF. CCF was measured both before and after airway insertion and without regard to the appropriateness of pauses (i.e., pausing CPR for an appropriately timed ventilation or pulse check) to ensure comparison with other CPR studies. We included all CPR process data available for the two minute periods before and after successful airway management.

The key exposure was the type of advanced airway device, defined as ETI or SGA. We included only successful insertions. In the few instances where a patient received both successful ETI and

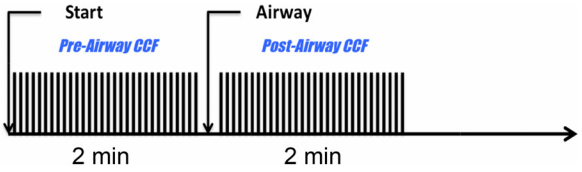

Fig. 1. Theoretical Model of CCF Surrounding Advanced Airway Insertion.