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Clinical paper

Tracheal intubation during pediatric cardiopulmonary resuscitation: A videography-based assessment in an emergency department resuscitation room☆

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ABSTRACT

Objectives: To describe procedural characteristics of tracheal intubation (TI) during cardiopulmonary resuscitation (CPR) in a pediatric emergency department, and to characterize interruptions in CPR associated with TI performance.
Methods: Retrospective single center case series. Resuscitations in a pediatric ED are videorecorded for quality improvement. Children who underwent TI while receiving chest compressions were eligible for inclusion. Intubations done by methods other than direct laryngoscopy were excluded. Background data included patient age and training background of intubator. Data on intubation attempts (success, laryngoscopy time) and chest compressions (interruptions, duration of pauses) were collected.
Results: Between December 2012 and February 2014, 32 patients had 59 TI attempts performed during CPR. Overall first attempt success at TI was 15/32 (47%); a median of 2 attempts were made per patient (range 1 to 4). Median laryngoscopy time was 47 s (range 8–115 s). 32/59 (54%) TI attempts had an associated interruption in CPR; the median interruption duration was 25 s (range 3–64 s). TI attempts without interruption in CPR were successful in 20/32 (63%) compared to 11/27 (41%) when CPR was paused ($p = 0.09$). Laryngoscopy time was not significantly different between TI attempts with (47 ± 21 s) and without (47 ± 26 s; $p = 0.2$) interruptions in compressions. 25/32 (78%) of pauses exceeded 10 s in duration.
Conclusions: TI during pediatric CPR results in significant interruptions in chest compressions. Procedural outcomes were not significantly different between attempts with and without compressions paused. In children receiving CPR, TI should be performed without pausing chest compressions.

Background

Cardiac arrest in the pediatric patient is frequently the result of respiratory insufficiency, with hypoxia and/or hypercarbia culminating in cessation of effective pulsatile blood flow. Population based studies have demonstrated that pediatric patients suffering out-of-hospital cardiac arrest due to non-cardiac causes have more favorable outcomes when ventilations and compressions are performed, as opposed to chest compressions alone.[1] Published guidelines on pediatric cardiopulmonary resuscitation continue to recommend positive pressure ventilation along with chest compressions for the child in cardiac arrest.[2]

Pediatric resuscitation guidelines recognize that an advanced airway in the form of an endotracheal tube is the optimal method of providing positive pressure ventilation. However, performing tracheal intubation (TI) in children can be challenging. Studies have uniformly shown a poorer success rate at emergency TI among pediatric patients than among adult patients in multiple clinical settings.[3] Advanced airway placement during CPR is fraught with technical challenges (e.g. blood or secretions in pharynx), the need for rapid completion of the procedure (minimizing interruptions in compressions), and the experiential challenges of a rare event at the provider level. Adult and pediatric prehospital cardiac arrest data has shown that tracheal intubation is not associated with improved

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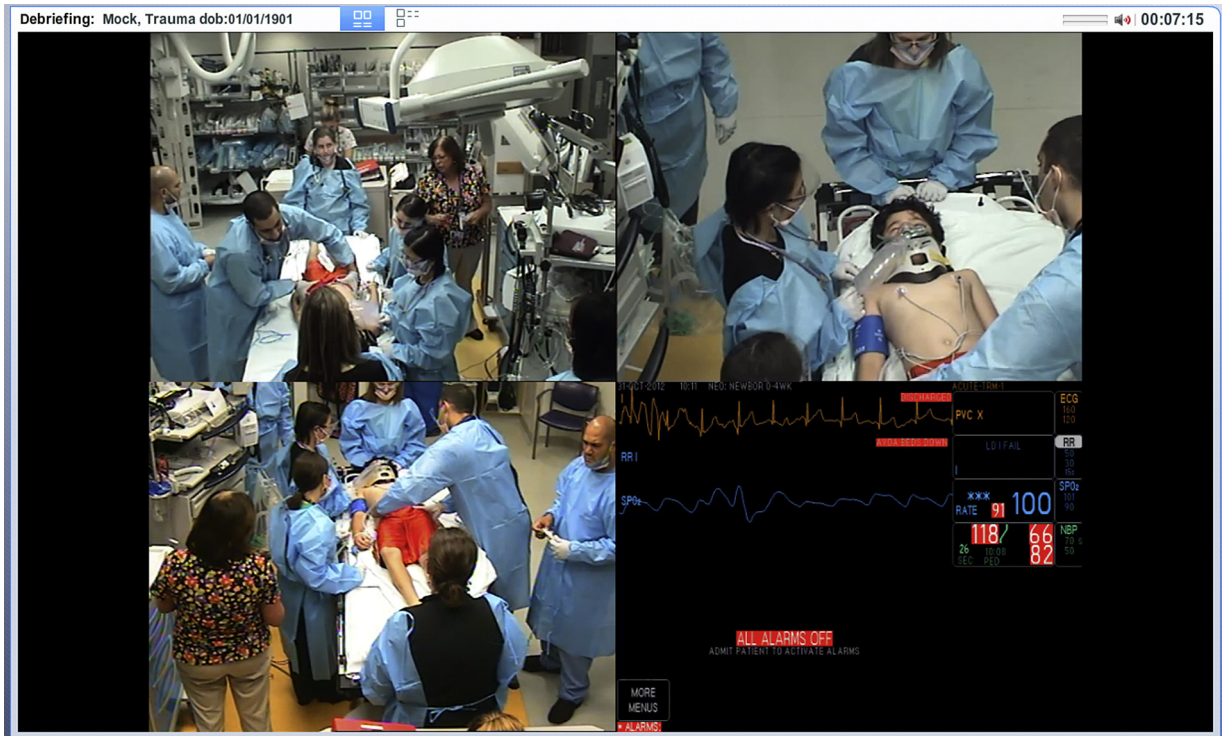

Fig. 1. Video recording system configuration (simulated patient).

survival.[4–6] Clinical studies documenting the impact of intubation on pediatric CPR performance are lacking in currently published literature.

We report data from a novel quality assurance and improvement program in a tertiary pediatric emergency department (ED) where resuscitative care is video-recorded. We sought to describe TI practice in pediatric patients receiving chest compressions. We hypothesized that TI attempts would constitute a significant source of interruptions in chest compressions, and that significant differences in success rates and duration of attempts would exist between attempts made with and without interruptions in chest compressions.

Methods

This was an observational study done in the emergency department of a single tertiary pediatric center between December 2012 and February 2015. Resuscitative care in the ED is video recorded as a part of a peer-reviewed, intradivisional continuous quality assurance program, created by a multidivisional task force including legal, risk management, and patient safety divisions. Patient/parent consent is obtained at the time of consent for treatment. Video-recording is done using three synchronized camera views (Fig. 1) plus a view of the monitor waveforms (LiveCapture, BLine Medical, Washington, DC). Videos are reviewed and deidentified data is collected on common resuscitative procedures, including CPR and TI. Following bimonthly video review sessions and data collection, videos are deleted after 30 days and are not retained as a part of the permanent patient medical record. Because the data was collected as part of an existing quality assurance program, the study was exempted from oversight by the Institutional Review Board of the Children's Hospital of Philadelphia.

Patients were eligible for inclusion if they had at least one attempt at TI while receiving chest compressions in the ED resuscitation bay under video-recorded conditions. Patients who underwent TI either before or after a period of chest compressions were excluded. Patients whose intubation and/or chest compressions were incompletely recorded on video were excluded. Patients were also excluded if they were intubated using a method other than direct laryngoscopy (e.g. videolaryngoscopy, fiberoptic bronchoscopy, surgical).

All data was collected by retrospective review of video recordings by members of the investigative team. Patients were categorized by age as either newborns (age 0–28 days), infants (age 28 days to one year), children (age 1 year to 7 years), and adolescent/adult (age > 8 years). Physicians attempting TI were categorized by level of training (resident, fellow, attending).

Chest compressions were considered 'interrupted' if a single provider stopped compressions for any reason, including to change compressors. Interruptions in compressions were measured in duration (seconds) and were secondarily dichotomized into greater than or less than 10 s; a minimum duration of 1 s was given to transient interruptions (e.g. a change in compressor that was rapidly accomplished). TI attempts were classified dichotomously as occurring with a pause in compressions (as defined above) or with compressions uninterrupted. Chest compression fraction was defined as the amount of time from the start of CPR to the conclusion of the event (ROSC or death) during which compressions were in progress, expressed as a percentage of the total arrest time.

A successful TI attempt was one where an endotracheal tube was successfully placed in the trachea prior to removal of the laryngoscope, as evidenced by exhaled carbon dioxide detection, either by colorimetric device or by waveform capnography (both of which are apparent from video review). Given that the patients being enrolled were in cardiac arrest, we anticipated that exhaled carbon dioxide detection might exhibit imperfect specificity (i.e. a successfully intubated patient might not yield detectable exhaled carbon dioxide); it was agreed a priori by the investigative team that such cases would be reviewed for secondary signs of successful tube placement such as chest wall motion with positive pressure. Time of laryngoscopy was defined as the time from insertion of a laryngoscope blade into the patient's mouth to the time when the blade was removed for any reason, whether a tube was inserted or not.