Critical Review Form
Prognosis

PGY-2

Wang HE, Simeone SJ, Weaver MD, Callaway CW. Interruptions in cardiopulmonary resuscitation from paramedic endotracheal intubation. Ann Emerg Med. 2009 Nov;54(5):645-652.

Objectives: "To characterize the frequency and duration of CPR interruptions associated with paramedic endotracheal intubation (ETI) efforts during out-of-hospital cardiopulmonary arrest."

Methods: This prospective observational study involved 2 EMS agencies from the Pittsburgh regional Resuscitation Outcomes Consortium center; one agency was a large urban paramedic service, the other a large rural EMS agency. Both agencies used protocols consisting of initial conventional ETI attempts. The urban agency used Combitube or King LT insertion or cricothyroidotomy in the case of failed intubation, while the rural agency used only cricothyroidotomy.

Consecutive out-of-hospital cardiopulmonary arrest patients treated from November 1, 2006 through June 20, 2007 were included. Exclusion criteria were:

1) **Age < 18 years**
2) **Victims of major trauma**
3) **Encounters without attempted resuscitation or advanced airway management.**

CPR and event data were collected using Philips MRX portable cardiac monitors that record electrocardiographic rhythm, ventilations, end-tidal carbon dioxide levels, and chest compressions by a sternal detector, in addition to digital audio records of all on-scene events. CPR interruption was defined as chest compression discontinuity of ≥ 5 seconds. CPR interruption due to airway insertion included those interruptions caused by bag-valve-mask ventilations and instances of primary alternate airway insertion without laryngoscopy.

Cases of insufficient data to define ETI-associated events (such as those with missing or noisy audio recordings or missing chest compression channel data) were excluded.

The primary outcomes were the number and duration of CPR interruptions associated with ETI attempts. Particular attention was paid to the duration of the initial CPR interruption, as well as the total summed duration of all CPR interruptions. The fraction of CPR interruption time due to ETI attempts was also calculated, using the automated total CPR interruption time reported by the manufacturer software program as the denominator. A sensitivity analysis was performed using CPR interruptions durations of 10 and 20 seconds.

There were 182 out-of-hospital cardiopulmonary arrests during the study period, of which 82 were excluded, leaving 100 cases in the analysis. Thirty-eight of the cases were excluded due to incomplete data.

Guide		Comments
I.	**Are the results valid?**	
A.	**Was the sample of patients representative?** *In other words, how were subjects selected and did they pass through some sort of "filtering" system which could bias your results based on a non-representative sample. Also, were objective criteria used to diagnose the patients with the disorder?*	No. In this study, the sample being evaluated includes both the EMS providers and the patients. EMS providers would likely have a larger effect on the number and duration and interruptions due to ETI (due to variables including airway training and experience), while the patient would have much less effect (due to variable such as body habitus). The EMS personnel studies were from the ROC center, and included one urban and one rural EMS agency. It seems unlikely that this sample would be representative of all EMS providers.
B.	**Were the patients sufficiently homogeneous with respect to prognostic risk?** *In other words, did all patients share a similar risk during the study period or was one group expected to begin with a higher morbidity or mortality risk?*	Uncertain. Again, looking at EMS providers, the authors do not provide any information regarding the level of experience or airway training of the personnel involved. These were out-of-hospital cardiac arrest patients, who have an overall high mortality rate. While there were some prognostic factors that would favor subsets of patients, such as those with a witnessed arrest, those who received bystander CPR, and those whose initial rhythm was VF/VT on EMS arrival (Sasson 2010), it is unclear if these factors would influence the number or duration of CPR interruptions. No information is given with regards to patient airway difficulty.
C.	**Was follow-up sufficiently complete?** *In other words, were the investigators able to follow-up on subjects as planned or were a significant number lost to follow-up?*	Yes. Outcome data was available for all 100 patients included in the analysis; the 38 patients without data were excluded prior to analysis.
D.	**Were objective and unbiased outcome criteria used?** Investigators should clearly specify and define their target outcomes before the study and whenever possible they should base their criteria on objective measures.	Yes and no. The primary outcome was clearly defined by the number and durations of CPR interruptions due to attempted ETI. An interruption was clearly defined as lasting at least 5 seconds, with sensitivity analyses performed using durations of 10 and 20 seconds. While current AHA guidelines stress the importance of minimizing chest compression interruptions, and improved neurologic outcomes have been demonstrated in a swine model (Kern 2002), it is unclear what impact this will have on mortality and neurologic survival in humans. Assessment of the cause of CPR interruption (ETI vs.

		other) was subjective, and determined by study personnel listening to audio recordings. Kappa values were calculated to assess inter-rater reliability.
II.	**What are the results?**	
A.	**How likely are the outcomes over time?**	Patient demographics: mean age 64 years, 61% male, 42% bystander CPR, 6% EMS witnessed OHCA, 21% VF/VT vs. 78% asystole, 73% transported to the hospital, 24% ROSC, 1% survival to hospital discharge. ETI efforts were associated with a median of 2 CPR interruptions per patient (IQR 1 to 3, range 1 to 9). Median duration of the 1st ETI-associated CPR interruption was 46.5 seconds per patient (IQR 23.5-73 seconds, range 7 to 221 seconds). Median total duration of ETI-associated CPR interruptions was 109.5 seconds per patient (IQR 54-198 seconds, range 13-446 seconds). The total ETI-associated CPR interruption time comprised approximately one fourth of the total CPR interruptions (median 22.8%; IQR 12.6%-36.5%, range 1.0%-93.9%). Inter-rater agreements for EMS agency A: • Case inclusion/exclusion: $\kappa = 0.87$ • Number of ETI-associated CPR interruptions: interclass correlation coefficient $\kappa = 0.68$ • Time to first ETI-associated CPR interruption: interclass correlation coefficient $\kappa = 0.87$ • Duration of first ETI-associated CPR interruption: interclass correlation coefficient $\kappa = 0.87$ • Total duration of all ETI-associated CPR interruptions: interclass correlation coefficient $\kappa = 0.59$
B.	**How precise are the estimates of likelihood?** *In other words, what are the confidence intervals for the given outcome likelihoods?*	See above.
III.	**How can I apply the results to patient care?**	
A.	**Were the study patients and their management similar to those in my practice?**	Yes. These were typically older, male patients (mean age 64, 61% male) with predominantly asystole or PEA arrest. We do not know what percentage of patients was seen by rural vs. urban EMS. Longer transport times by rural EMS agencies may result in longer total CPR interruption time, but should not affect duration and number of ETI-

		associated interruptions.
B.	**Was the follow-up sufficiently long?**	Yes. All cases were followed until the termination of CPR, allowing all instances of CPR interruption to be captured.
C.	**Can I use the results in the management of patients in my practice?**	Uncertain. While the duration and number of ETI-associated CPR interruptions is quantified here, several important questions remain to be answered: 1) How does the total duration of CPR interruption in cases of attempted ETI compare to protocols that do not involve ETI, but instead use either alternate airway devices (Combitube, King LT), BVM ventilation only, or passive ventilation. 2) How do these various protocols affect patient-important outcomes, such as survival to hospital discharge, neurologically intact survival, and neurologic status.

Limitations:

1) **Equipment malfunction led to exclusion of 38 patients. There was no way to compare this group to those included. Inclusion of these patients could have led to different results.**
2) **A surrogate outcome was measured, rather than assessing patient important outcomes (neurologically intact survival, neurologic outcomes, quality of life).**
3) **The assessment of EMS actions at times of CPR interruption was based on digital audio, which was both subjective and not validated (though kappa values showed good inter-rater reliability). However, as the authors note, logistic and ethical issues may make the use of video impossible.**
4) **The training level and experience of the paramedics involved was not well-documented. Additionally, the ROC-associated EMS personnel may not be representative, due to their inclusion in multiple study protocols and relatively more urban environment, with different practice patterns than more remote rural locales.**

Bottom Line:

ETI efforts were associated with a median of 2 CPR interruptions and 109.5 seconds total duration of ETI-associated CPR interruption per patient. The total duration of ETI-associated CPR interruption was one-fourth the total CPR interruption time. The data show that ETI in out-of-hospital cardiac arrest results in an increase in CPR interruption. Other studies have suggested that minimizing interruptions in chest compressions results in improved mortality (Bobrow 2008, Garza 2009).