Evaluation of the Effect of Prehospital Application of Continuous Positive Airway Pressure Therapy in Acute Respiratory Distress

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Abbreviations:
CPAP = continuous positive airway pressure
ED = emergency department
EMS = emergency medical services
ICU = intensive care unit
LOS = length of stay

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Abstract

Objective: The impact of the use of mask continuous positive airway pressure (CPAP) on patients with acute respiratory distress in the prehospital, rural setting has not been defined. The goal was to test the use of CPAP using the Respironics® WhisperFlow® CPAP in patients presenting with acute respiratory distress. This was a collaborative evaluation of CPAP involving a rural EMS agency and the regional medical center. Patient outcomes including the overall rate of intubation-both in the field and in the emergency department (ED), and length of stay in the hospital and Intensive Care Unit (ICU) were tracked.

Methods: The study was an eight-month, crossover, observational, non-blinded study.

Results: During the four months of baseline data collection, 7.9% of patients presenting with respiratory distress were intubated within the first 48 hours of care. Their average ICU length of stay was 8.0 days. During the four months of data collection when CPAP was available in the prehospital setting, intubation was not required for any patients in the field or in the ED. Admissions to the ICU decreased. Those patients admitted to the ICU, the average ICU length of stay deceased to 4.3 days.

Conclusions: The use of the CPAP in the prehospital setting is beneficial for patients in acute respiratory distress.

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Introduction

Continuous positive airway pressure (CPAP) therapy quickly is becoming a standard of care for the management in-hospital respiratory distress management.[1] Continuous positive airway pressure therapy has been shown to rapidly improve vital signs, gas exchange, the work of breathing, to decrease the feelings of dyspnea, and decrease the need for endotracheal intubation in patients who suffer from respiratory distress from congestive heart failure (CHF), pulmonary edema, asthma, chronic obstructive pulmonary disease (COPD), and pneumonia.[2] For patients with CHF, CPAP additionally improves hemodynamics by reducing preload and afterload.[3] Emergency medical services (EMS) are beginning to realize the benefit of employing CPAP therapy for patients with respiratory distress in the out-of-hospital setting.[4] Many of the benefits of application of CPAP by prehospital EMS agencies include improved patient outcomes and cost-savings by the receiving hospitals.[5,6]

Methods

Design, Population, and Setting

This study was a two-part, non-blinded, observational study. Cullman EMS is the 9-1-1 advanced life support (ALS) ambulance provider serving a suburban-rural population of approximately 80,000 residents in north Alabama, US. All emergency medical calls were screened for patients who met the criteria for respiratory distress (RD). Signs and symptoms of RD typically are seen in

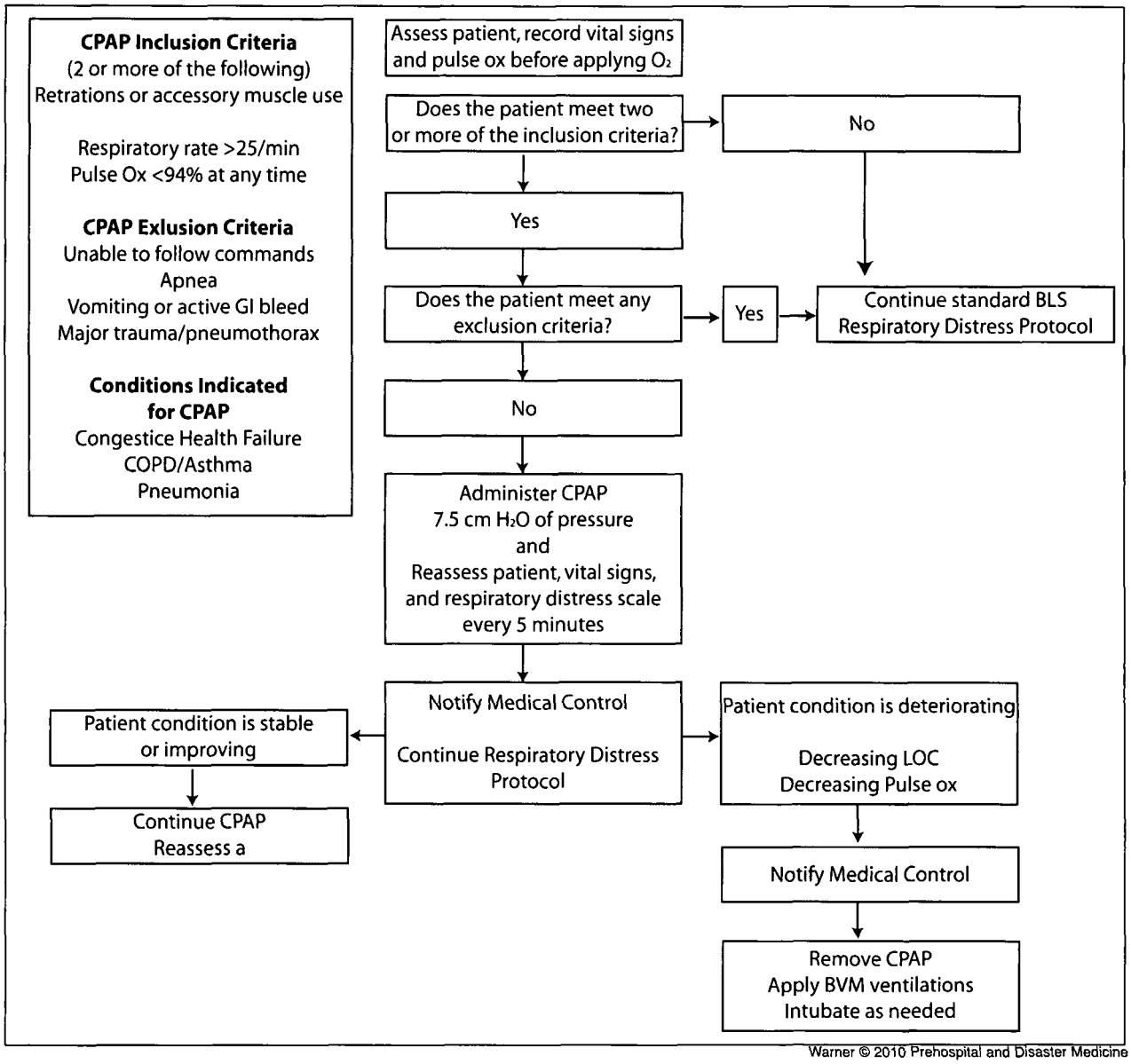

Figure 1—Continuous Positive Airway Pressure (CPAP) algorithim (BLS = basic life support; BVM = bag-valve-mask; COPD = chronic obstructive pulmonary disease; GI = gastrointestinal; LOC = loss of consciousness)

patients with decompensated congestive heart failure (CHF), pulmonary edema, asthma, exacerbation of chronic obstructive pulmonary disease (COPD), or pneumonia.

The inclusion criteria included any patient ≥12 years of age who was in *acute respiratory distress* as defined as dyspnea, ventilatory rate >25 per minute, and/or retractions or accessory muscle use, and arterial hypoxemia as evidenced by a pulse oximetry oxygen saturation of <95% in spite of the administration of supplemental oxygen. Other criteria for inclusion included mental alertness (Glasgow Coma Score>10), the ability to maintain an open airway, and a systolic blood pressure >90 mmHg. The CPAP algorithm employed is in Figure 1.

Baseline data were collected for four consecutive months from November 2007 through February 2008. Patients were enrolled who met the definition of acute respiratory distress noted above. Usual therapy based on Alabama State EMS Protocols were utilized including the administration of oxygen, bronchodilators, diuretics, and intubation as needed. During the treatment portion of the cross-over period, all of the paramedics were trained and each ambulance was outfitted with the Respironics® WhisperFlow® CPAP device. Based on a previous prehospital study comparing CPAP pressures of 5, 7.5, 10, 12.5 cm H_2O pressure, the 7.5 cmH_20 was optimal in 85% of adults with acute respiratory distress.[7] Based on this data we used the 7.5 cm H_2O valve was selected as the starting pressure. Four months of treatment data with CPAP available to the prehospital providers was collected from March 2008 through June 2008 on all of the patients who met the inclusion criteria. Patients were excluded if they had any of the following contraindications: (1) ventilatory arrest; (2) suspected of having a pneumothorax/penetrating chest trauma; (3) tracheostomy; (4) agonal ventilations; (5) unconsciousness; (6) persistent nausea and vomiting; (7) facial trauma or malformation; (8) active upper gastrointestinal bleeding or recent gastric

	Pre-CPAP n = 89	Post-CPAP n = 106
Intubation in field n (%)	3 (3.4)	0 (0)
Intubation in ED n (%)	4 (4.5)	0 (0)
Admission to hospital n (%)	18 (20.2)	9 (8.5)
Admission to ICU n (%)	13 (14.6)	3 (2.8)
ICU LOS (mean days)	8.0	3.0
Hospital LOS (mean days)	10.75	4.6

Table 1—Continuous Positive Airway Pressure (CPAP) algorithim

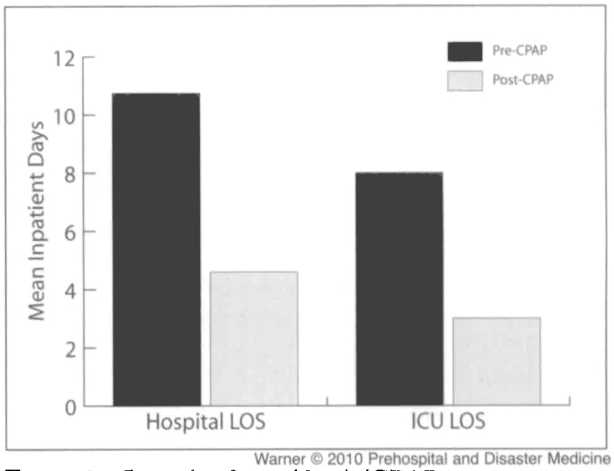

Figure 3—Length of stay (days) (CPAP = continuous positive airway pressure; ICU = intensive care unit; LOS = length of stay)

surgery (<2 weeks); and (9) children <12 years of age and of average size. The procedure that was used for the application of the CPAP device to appropriate candidates who gave verbal consent is outlined in Appendix 1.

Results

During the four months of baseline data collection, a total of 89 patients met the inclusion criteria. Of these, seven (7.9%) were intubated within the first 48 hours of care: 3 (3.4%) were intubated in the field and 4 (4.5%) were intubated in the emergency department (ED). Four (4.5%) received CPAP therapy after coming to the ED. Ten patients (12.4%) received some ventilatory assistance with mechanical ventilation or CPAP within the first 48 hours of 9-1-1 contact. For the eight patients (72.2%) admitted to the intensive care unit (ICU), the average length of stay in the ICU was 8.0 days (range 5–13 days). Of those admitted, 75% went to the ICU. The total hospital LOS was 10.8 days (range 1–19 days). The discharge rate from the ED was 11% (Table 1).

During the four months with CPAP available to the prehospital EMS providers, 106 patients were identified who met the inclusion criteria. No patient who received CPAP required endotracheal intubation in the field and, similarly, none of the patients (0%) subsequently were intubated in the ED. In the prehospital setting, CPAP was initiated in 20 patients (18.9%), and one patient (0.9%) received CPAP in the ED. A total of 21 patients (19.8%) received some ventilatory assistance with mechanical ventilation (MV) or CPAP within the first 48 hours of 9-1-1 contact. A total of 14 (17%) were continued on CPAP in the hospital. The average LOS in the ICU was 3.0 days (range 1–6 days; Figure 2). Of the nine admitted, three (33.3%) went to the ICU. The total hospital LOS was 4.6 days (range 1–13 days). The discharge rate from the ED was 15%. There were no untoward effects.

Discussion

Continuous positive airway pressure has been shown to rapidly improve vital signs, gas exchange, the work of breathing, decrease the sense of dyspnea, and decrease the need for endotracheal intubation in patients who suffer from respiratory distress from CHF, pulmonary edema, asthma, COPD, or pneumonia. Emergency medical services are beginning to realize the benefit of employing CPAP therapy for acute respiratory distress in the out-of-hospital setting. While the total inpatient admission rate only decreased by 3% since beginning CPAP administration in the prehospital setting in this study, the utilization of critical care resources has decreased dramatically. In addition, even those who did need ICU admissions, the length of stay has decreased. The total usage of any ventilatory assistance (MV or CPAP) increased from 12.4% to 19.8% after the availability of CPAP to prehospital emergency providers. This increase may reflect a learning curve, awareness, and a novel treatment modality. The benefits of the use of CPAP in patients with acute respiratory distress have been encouraging both to patients and the EMS providers. Continuous positive airway pressure therapy is relatively easy to use and generally is well-tolerated. Many of the benefits of EMS application of CPAP represent improved patient outcomes and cost-savings from the receiving hospitals.[3] Given the recurrent reimbursement schema, the cost of equipment should be shared between EMS providers and hospitals as the hospitals are often the beneficiary of decreased ventilator usage and decreased LOS.[6] The only potential drawbacks of CPAP therapy include the additional cost to EMS agencies and hypothetical deterioration of intubation skills with shrinking numbers of conscious patients requiring an artificial airway in the prehospital arena. Emergency medical service medical directors should remain vigilant to ensure provider's airway skills are maintained.

Limitations

The limitations of this study include the fact that it was a small observational, non-randomized study and is not powered to make statistical conclusions regarding causation. The decision to use CPAP was based on a set of criteria but ultimately was derived from subjective paramedic decision-making. The patients were not matched using any objective criteria to the cohort prior to CPAP and were not random-

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ized. Selection bias may be present and could skew results. Although the number of patients was fairly equal in both arms, adjustments were not made for potential seasonal variations. Patients were not sorted by common causative diagnoses such as CHF, pulmonary edema, asthma, COPD, or pneumonia. Although hospital and ICU LOS were followed, mortality was not included. Other CPAP devices were not used, nor were other CPAP pressures above or below 7.5 cm H_2O. Four patients in the pre-CPAP cohort and one patient in the post-CPAP cohort were lost to follow-up as they were transported to other hospitals.

Conclusions

Since the initiation of the prehospital CPAP program, there has been a decreased need for prehospital and ED rates of intubation in patients presenting with respiratory distress. Paramedics, who initially were skeptical about the efficacy or ease of CPAP, have been won over by their first-hand experience with this simple and rapidly effective tool. The ED staff noted patients improving more quickly and allowing less admissions and shorter times in the ED. In addition, hospital administration has realized the benefits of decreased hospital LOS and ICU utilization. The CPAP therapy was well received by patients, their families, and providers. No adverse reactions or identifiable complications were encountered. The experience with prehospital CPAP has been overwhelmingly positive.

Acknowledgements

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Appendix—Procedure for the application of the CPAP device to appropriate candidates who gave verbal consent. (CHF = congestive heart failure; COPD = chronic obstructive pulmonary disease; CPAP = continuous positive airway pressure)

1. Screen for possible pneumothorax.
2. Explain the procedure to the patient.
3. Ensure adequate oxygen supply to ventilation device. If using a portable O2 cylinder, ensure that at least 1,000 PSI remain.
4. Place patient on continuous pulse oximetry.
5. Connect the Whisperflow® to the oxygen source.
6. Place the delivery device mask over the mouth and nose. Patient may hold mask against face themselves in order to acclimate. Once the patient is comfortable with the pressure, straps may be used to ensure adequate seal and delivery of pressure and oxygen.
7. Secure the mask with provided straps. Tighten as needed to ensure little or no air leak.
8. For adults, apply 7.5 cm H_2O CPAP valve to the WhisperFlow® system.
9. Check for air leak.
10. Monitor and document the patient's respiratory response to treatment.
11. Due to changes in preload and afterload of the heart during CPAP therapy, a complete set of vital signs needs to be obtained every 5 minutes.
12. Continue to coach patient to keep mask in place and readjust as needed.
13. If respiratory status deteriorates, remove device and consider use of a bag-valve-mask (BVM) ventilation with or without endotracheal intubation. Intubation should be performed if respiratory or cardiac arrest or unresponsive to verbal stimuli (*Glasgow Coma Scale Score (GCS) <9*).
14. Contact the hospital to be prepared for an incoming patient on CPAP. The goal is a seamless transition by the receiving respiratory therapist to CPAP in the emergency department. Bring the mask and tubing in with the patient.
15. Depending on patients underlying problem (i.e., CHF, pulmonary edema, COPD) follow additional appropriate treatment protocols. Paramedic may administer an albuterol nebulizer treatment while using CPAP device if equipped.
16. Monitor for development of pneumothorax.

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