

The impact of pre-hospital non-invasive positive pressure support ventilation in adult patients with severe respiratory distress: A systematic review and meta-analysis

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Introduction

- Non-invasive positive pressure ventilation (NIPPV) has been shown to reduce mortality, intubation rates, and intensive care unit (ICU) length of stay (LOS) for patients admitted to hospital with acute cardiogenic pulmonary edema (ACPE) and acute exacerbation of chronic obstructive pulmonary disease (COPD)
- NIPPV is increasingly being used by Emergency Medical Services (EMS) for the treatment of respiratory distress in the pre-hospital setting

Objectives

Primary Objective

 To determine if out-of-hospital administered NIPPV for the treatment of adults (age ≥16 years) with severe respiratory distress reduces 30-day mortality compared to 'standard' therapy

Secondary Objectives

 To examine the effect of pre-hospital administered NIPPV on the need for invasive ventilation, intensive care unit (ICU) length of stay (LOS), hospital LOS and complications from NIPPV

Methods

- Electronic searches of Medline, EMBASE, Cochrane Central Register of Controlled Trials, and CINAHL were conducted and reference lists for relevant articles were hand searched
- Randomized controlled trials comparing the use of out-of-hospital NIPPV to 'standard' therapy in adults (age ≥16 years) in severe respiratory distress with a suspected diagnosis of ACPE, AECOPD, or acute asthma exacerbation were included
- Two reviewers independently screened titles and abstracts, assessed the quality of the studies, and extracted data
- Where appropriate, data were pooled using random-effects models and reported as risk ratios (RR) with 95% confidence intervals (Cls) and number needed to treat (NNT)

734 citations identified from electronic search 717 did not meet eligibility criteria / duplicate citations 17 potentially relevant studies retrieved in full text 10 studies excluded: - wrong study design (9) - intervention inappropriate (1)

Figure 1. Flow diagram of included studies.

	NIPPV		Standard		Risk Ratio		Risk Ratio	
Study or Subgroup	Events	Total	Events	Total	Weight	M-H, Random, 95% CI	M-H, Random, 95% CI	
Ducros 2011	8	107	9	100	29.4%	0.83 [0.33, 2.07]		
Frontin 2011	6	60	7	60	23.1%	0.86 [0.31, 2.40]		
Plaisance 2007	2	63	8	61	10.7%	0.24 [0.05, 1.09]	-	
Roessler 2012	1	24	3	25	5.1%	0.35 [0.04, 3.11]	-	
Schmidbauer 2011	0	18	0	18		Not estimable		
Thompson 2008	5	35	12	34	28.3%	0.40 [0.16, 1.03]		
Weitz 2001	1	10	1	13	3.5%	1.30 [0.09, 18.33]		
Total (95% CI)	317 311		311	100.0%	0.58 [0.35, 0.95]	•		
Total events	23		40					
Heterogeneity: Tau ² = 0.00; Chi ² = 3.59, df = 5 (P = 0.61); I ² = 0%								
Test for overall effect: $Z = 2.15$ (P = 0.03)								

Figure 2. In patients treated with pre-hospital NIPPV, the pooled estimate showed a reduction in 30 day mortality (RR: 0.58; 95% CI: 0.35, 0.95; NNT=17)

	NIPPV		Standard		Risk Ratio		Risk Ratio
Study or Subgroup	Events	Total	Events	Total	Weight	M-H, Random, 95% CI	M-H, Random, 95% CI
Ducros 2011	4	107	13	100	16.1%	0.29 [0.10, 0.85]	
Frontin 2011	2	60	3	62	6.2%	0.69 [0.12, 3.98]	
Plaisance 2007	6	63	16	61	25.1%	0.36 [0.15, 0.87]	
Roessler 2012	1	24	6	25	4.6%	0.17 [0.02, 1.34]	
Schmidbauer 2011	3	18	7	18	13.6%	0.43 [0.13, 1.40]	
Thompson 2008	7	35	17	34	34.5%	0.40 [0.19, 0.84]	
Total (95% CI)	307			300	100.0%	0.37 [0.24, 0.58]	•
Total events	23		62				
Heterogeneity: Tau² =	0.00; Chi	0.01 0.1 1 10 100					
Test for overall effect:	$Z = 4.44 \ ($	Favours NIPPV Favours Standard					

Figure 3. In patients treated with pre-hospital NIPPV, the pooled estimate showed a reduction in need for invasive ventilation (RR: 0.37; 95% CI: 0.24, 0.58; NNT=8)

Trial	Type of Disease	NIPPV (cmH ₂ O)	'Standard' Care	STD	TX
Plaisance	ACPE	CPAP-	Diuretics, O ₂	61	63
(France)		7.5	NTG, CCB, ionotropes,		
Frontin	ACPE	CPAP-	Diuretics, nitrates, O ₂	62	60
(France)		10			
Schmidbauer	AECOPD	CPAP-	O_2	18	18
(Germany		Unclear			
Thompson	Severe Resp	CPAP-	Diuretics, morphine, O _{2,}	35	36
(Canada)	Distress	10	NTG, bronchodilators,		
Weitz	ACPE	BiPAP-	Diuretics, NTG,	13	10
(Germany)		12.5/5	morphine, O ₂		
Ducros	ACPE	CPAP-	Diuretics, nitrates,	100	107
(France)		7.5-10	ionotropes, O ₂		
Roessler	ACPE,	CPAP-	Bronchodilators, dex,	25	24
(Germany)	AECOPD,	5-20	opiates, Lasix, O ₂		
	pneumonia				

- 7 RCTs were included with a total of 632 patients; 313 in the 'standard' therapy group and 319 in the NIPPV group
- There was no difference in ICU or hospital LOS
- In the 2 studies that reported complications, 3 patients (1.0%) receiving NIPPV experienced emesis

Limitations

- No standard modality or treatment dose/length for administering NIPPV across the included RCTs
- Clinical heterogeneity as patients included had diagnoses which included asthma, COPD, and ACPE
- Future studies should aim to delineate the safety and efficacy of NIPPV for expanded disease processes such as asthma and pneumonia

Conclusions

- Pooled estimate showed a reduction in both 30-day mortality (NNT=17) and need for invasive ventilation (NNT=8)
- EMS systems should adopt NIPPV as the standard of care for the treatment of adult patients prehospital with severe respiratory distress